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# English Make Centrifugal Castings

## Process for Making Gray-Iron and Nonferrous Castings Fully Described—Micrographs Show Effects of the Centrifugal Force—Parts for Gas Washer Sand Cast

BY H. COLE ESTEP
*European Manager of The Foundry*

WITH all their tradition for "measured speech and ordered action", for unchanging methods and great deliberation in adopting new ideas, the English are a singularly inventive people. The history of British engineering is replete with the records of great innovations including such outstanding landmarks as the steam engine, the power loom, the electric dynamo, and the military tank. Therefore, it is not inconsistent to find British engineers blazing new trails in the foundry field, an industry which has been profoundly affected by the work of inventors, with at the same time very little change in its fundamental methods since before Dud Dudley made his first iron castings in 1619.

The production of iron castings by centrifugal force in permanent iron molds does, however, represent a distinct departure from accepted foundry traditions. British foundrymen have been among the leading pioneers in this new development, and in several shops in the United Kingdom the process is now on a commercial basis with every prospect of marked expansion in the future. For certain classes of castings, mainly cylindrical, that is within certain limitations which those most favorably disposed toward the centrifugal method have been prompt to recognize, this new method of casting iron and nonferrous metals shows great promise in both engineering and commercial directions. Although it has made its greatest strides in the piston-ring industry, the centrifugal method is by no means confined to that sphere.

At present about a dozen centrifugal casting machines of the modern horizontal type are commercially installed in England, with plans for further installations in at least one new shop. Over half the existing machines are in the plant of Stokes Castings Ltd., at Mansfield, in the midlands of England a few miles north of Nottingham. Mansfield is in the center of the historic Robin Hood country, but most of the Greenwood has given way to foundries, ma-

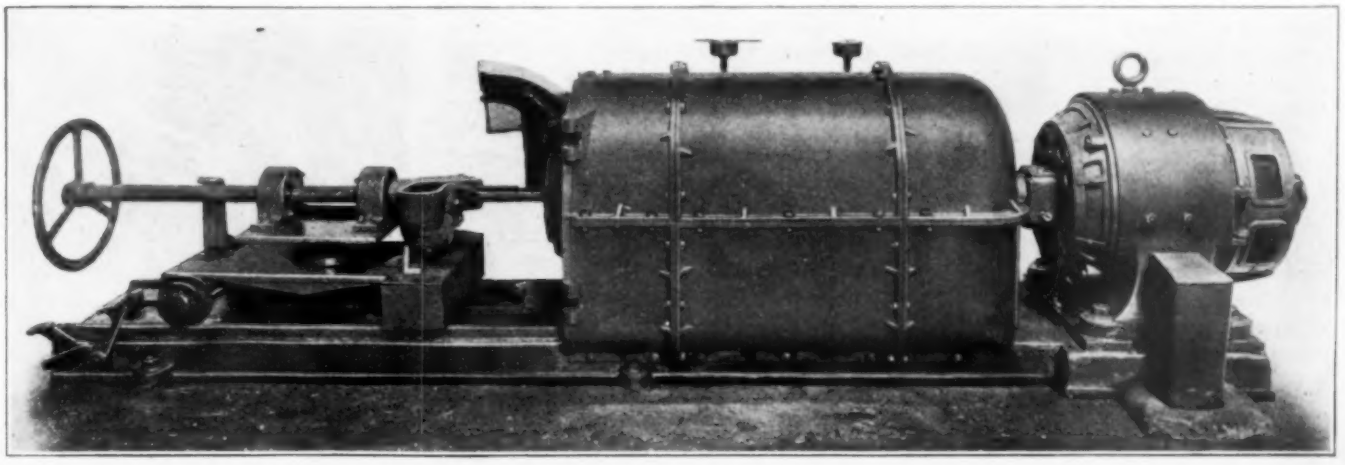


FIG. 1—THE LATEST TYPES OF CENTRIFUGAL CASTING MACHINES ARE DIRECT MOTOR DRIVEN AND FULLY ENCLOSED

chine shops, and coal mines. The Stokes company operates the Union foundry as the successor to the old-established firm of Sansom Bros. & Co., and is one of the pioneers and perhaps at present the chief protagonist of the centrifugal casting process in either England, America, or elsewhere. This company is representative of many old-line English firms, especially in the foundry and engineering fields, which are branching out in new directions, with the result that a quiet revolution is taking place in Great Britain, both in business and

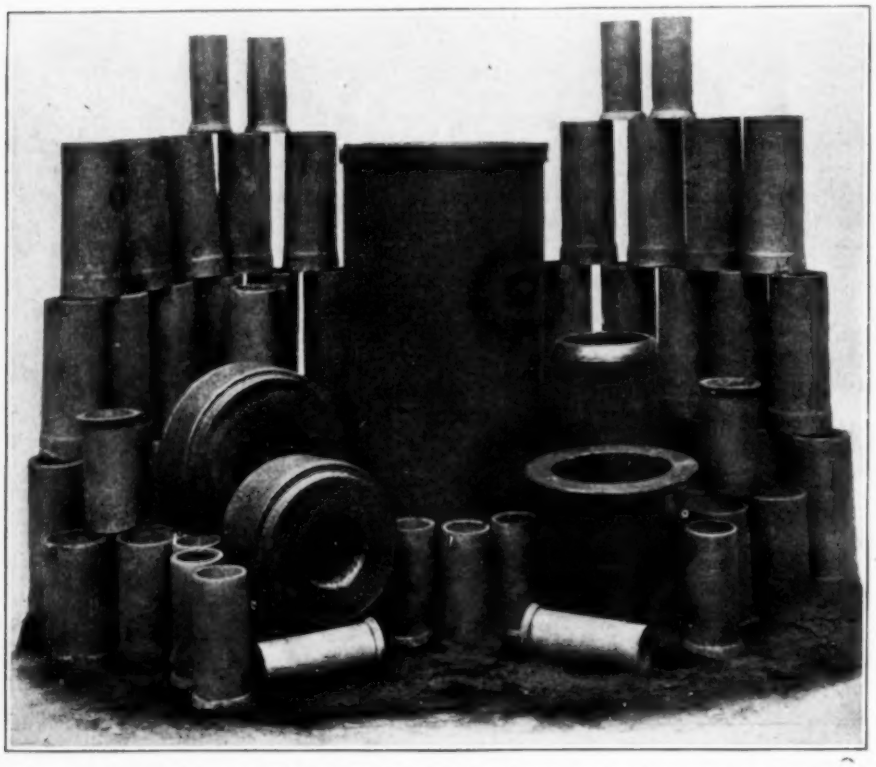


FIG. 2—CENTRIFUGALLY CAST DRUMS FOR MAKING PISTON RINGS OF VARIOUS SIZES TOGETHER WITH OTHER CENTRIFUGAL CASTINGS

technical methods—a revolution which will have the effect, probably before the world realizes it has transpired, of considerably enhancing Britain's traditional pre-eminence in the metal working industries.

In addition to F. W. Stokes, managing director, the directors of Stokes Castings Ltd., include, James Richardson, chairman; Arthur M. Stokes, secretary; Richard I. Ashley, Sidney Hersey, and William A. Oubridge, whose activities in the centrifugal casting field have already been covered in THE FOUNDRY.

Although specially equipped for making centrifugal castings, the Stokes company does not confine itself to this class of work, operating in addition an extensive gray-iron foundry for making heavy castings in sand molds, together with a machine shop and auxiliary departments. Gas works equipment is one of the principal products of these departments, a large amount of export business being done. The company employs about 200 men, the foundries having a weekly capacity of about 50 tons.

A wide range of product is turned out, and some of the features of the sand molding practice are discussed later in this article, which is mainly concerned with centrifugal casting methods.

The centrifugal department of the Union foundry contains one large and six medium size machines, together with two cupolas and auxiliary apparatus for the weekly production of about 3000 piston-ring pots or other centrifugal castings. The smaller machines make castings up to 7½ inches in diameter and the large one up to 16 inches. Since the volume of metal to be handled is not large, a cupola 22 inches in diameter inside of lining with a capacity of about two tons an hour, furnished by Jackman & Co., Manchester, suffices, with a small tilting cupola for experimental work and light heats, built by the Constructional Engineering Co. Ltd., Birmingham, in reserve. The blast is furnished by Sturtevant fans, and a blast pressure of 12 to 13 ounces is carried on the larger cupola and 10 ounces on the smaller one.

The manufacture of pots or blanks for piston rings represents the principal application of the centrifugal casting process up to date. The Stokes company stocks pots in all sizes from the smallest to the largest, graded both in millimeter and inch

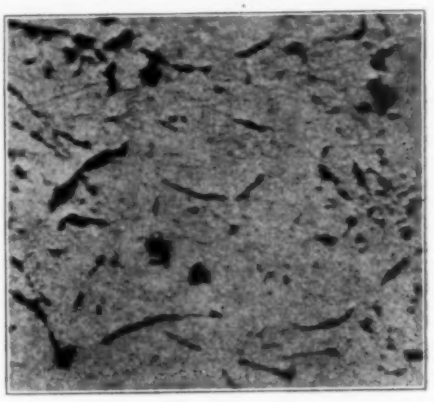


FIG. 3—MICROSTRUCTURE OF SAND CASTING SHOWING GRAPHITE PLATES

sizes. It makes no sand-cast piston-ring pots, believing that the fine distribution of graphitic carbon in the centrifugally cast metal, coupled with its fine grain, elasticity, strength, and uniformity, especially recommend it for this class of work.

The centrifugal method, it has been demonstrated at Mansfield, has much wider applications than in the piston ring field. Diesel-engine cylinder sleeves also are made successfully by this method, as are valve sleeves for Knight-type gasoline engines. The latter may be cast with dry-sand cores forming the ports, the cores being set in the revolving mold before each casting is poured. Piston-rod glands for pumps and steam engines also are cast centrifugally, together with rings or cylinders with bosses or projections either on the ends or in the middle, the latter being formed by loose pieces in the mold. The manufacture of

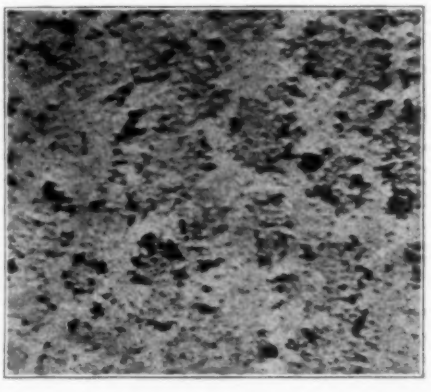


FIG. 4—MICROSTRUCTURE OF CENTRIFUGAL CASTING SHOWING FINE GRAPHITE

hardened, or chilled cams, forms another outlet for the products of the centrifugal casting machine.

This process also commends itself

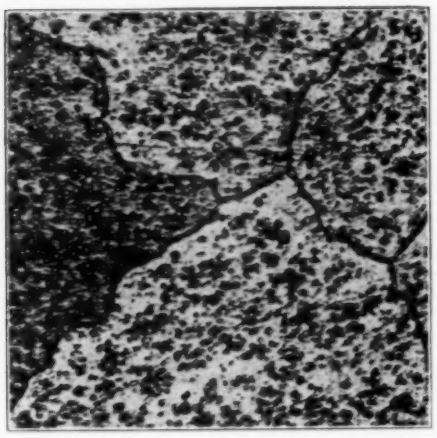


FIG. 5—STRUCTURE OF 50-50 CHILL-CAST BRASS INGOT

to the production of wear-resisting bushings, bearing bronzes and brasses of all types, as well as aluminum specialties and water-pump liners. The applications of the centrifugal process to the nonferrous metals are believed in some directions to surpass those which may be developed for the production of iron castings. The qualities of denseness, uniformity of structure, and fineness of grain possessed by centrifugally cast metal are particularly useful in bearing bronzes, and journals provided with liners of this type are said to have unusually long life.

The structure of centrifugally cast specimens of gray iron has been described in previous issues of THE FOUNDRY. The character of this metal is illustrated in Figs. 3 and 4, showing the respective structures of sand and centrifugal castings. In the latter the graphite plates, which are a common characteristic of gray iron, are broken up into a finely divided form, more like temper carbon in malleable castings. This gives a closer grained stronger structure than some forms of ordinary castings, while at the same time the total amount of graphitic carbon is not reduced and

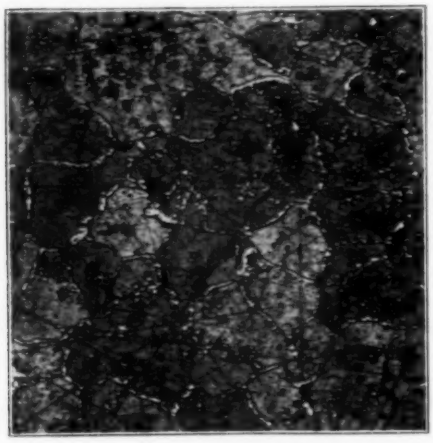


FIG. 6—STRUCTURE OF 50-50 BRASS CENTRIFUGALLY CAST

the iron is therefore more readily machineable.

With the nonferrous metals, the differences in microstructure between sand or plain chill cast, and centrifugally cast specimens is even more marked than in the case of iron. This is clearly shown in Figs. 5 and 6, and 8 and 9, showing 50-50 and 60-40 brass respectively. Each of the specimens is magnified 80 diameters. In the case of the brass containing 50 per cent copper and 50 per cent zinc, the change of structure to a more dense uniform metal is marked, but is even more striking in the 40-60 alloy. The latter in the chill-cast ingot has an exceedingly coarse segregated structure which is completely transformed by the centrifugal operation, so much so that one might say

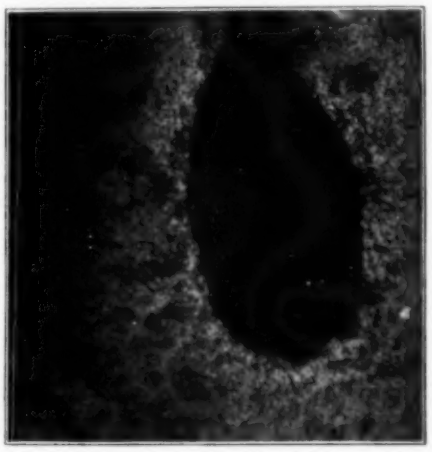


FIG. 7—MICROGRAPH OF PINHOLE IN CENTRIFUGAL CASTING—X 100 DIA.

the innate nature of the alloy had been modified. This results from the combined wrapped and welded nature of the centrifugal casting.

*Brass and Iron Combined*

Although some difficulties remain to be worked out, the centrifugal method also may be employed for making compound castings, that is, iron rings or tubes with brass linings welded to the iron shell. This opens up a large field in the form of noncorrosive tubes, containers, etc., cheaper and stronger than solid brass. In making castings of this type, the nonferrous alloy is poured into the spinning mold immediately after the iron and before the latter has had time to cool below the welding heat. The difficulty arises in the formation of an oxide film of the welding surface of the iron. This film forms very quickly and prevents thorough union of the two metals. Experiments are now under way to overcome these difficulties.

Mr. Stokes and certain other engineers have expended a large amount of effort in perfecting the centrifugal

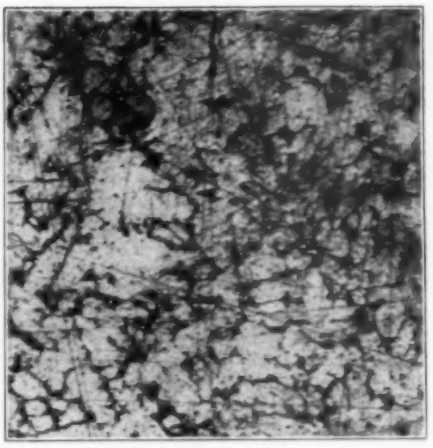


FIG. 8—STRUCTURE OF 60-40 BRASS CENTRIFUGALLY CAST

casting machine, which after all represents the heart of this process. As the result of a long series of experiments a practical machine has now been evolved from crude beginnings. A general view of the latest type developed by Stokes Castings Ltd., is shown in Fig. 1. The machine and the process generally is patented in Great Britain, the United States, and elsewhere.

Essentially it is a device for rapidly spinning a cylindrical iron mold in which the castings are made. As in most modern machines of this class, the mold is spun on a horizontal rather than a vertical axis. The machine, as indicated in Fig. 1, consists essentially of a base plate, a driving motor, shaft, clutch, mold-carrying face plate, and pouring device. An iron housing protects the moving parts.

The driving motor is mounted at one end of the base plate, and is connected to the shaft by a flexible coupling which absorbs any slight irregularities in alignment. A 6-horsepower motor is employed on the 7½-inch machine, the average power consumption, however, being 3½ horsepower, when starting. The motor is

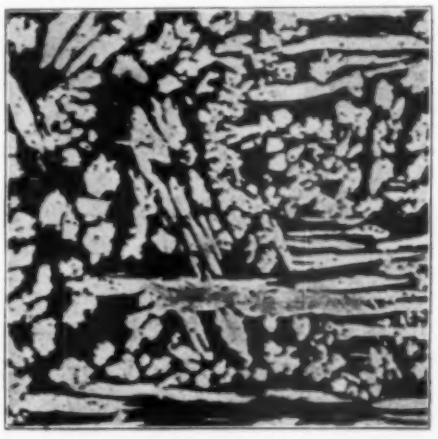


FIG. 9—STRUCTURE OF 60-40 BRASS INGOT, CHILL-CAST

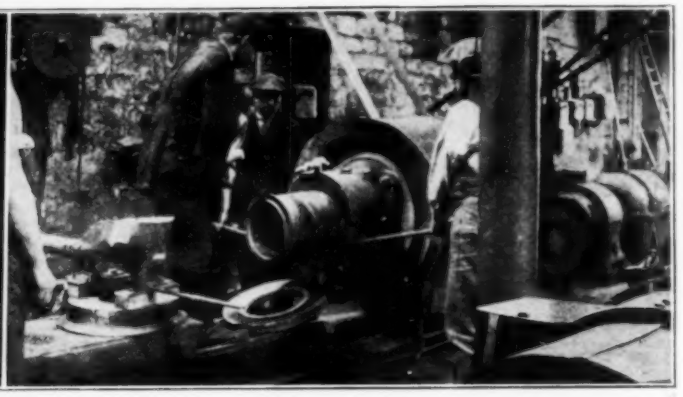


FIG. 10—POURING METAL FOR CENTRIFUGAL CASTINGS FIG. 11—EXTRACTING CASTING FROM DIE IN CENTRIFUGAL PROCESS—NOTE THE REMOVAB LE COVER PLATE IN THE MOLD

of the variable speed type running up to 1700 revolutions per minute. A friction clutch of the ordinary automobile type also is interposed between the motor and the face plate. The clutch is operated by a foot pedal and with it the machine may be stopped and started at will. The clutch is one of the distinctive features of the Stokes machine, and its use is said to result in a considerable saving of power. When clutching in the motor is speeded down to about 400 revolutions, so as to reduce the inertia shock in starting the machine.

The drive-shaft, which is carried in ball and roller bearings to reduce the friction, terminates in a face plate not unlike that on a lathe. A die holder, which in turn carries the die or permanent mold, is bolted to the face plate. The outer end of the die holder is fitted with a cover plate which holds the die in place. The cover plate is recessed on the back side to receive a thin plate, called a gage plate, its purpose being to gage the thickness of the casting by forming a lip at the outer end of the die. The hole in the gage plate corresponds in diameter with the inside diameter of the casting to be made.

The pouring device, as indicated in Fig. 1, consists of a small platform truck running on rails cast on the base plate, the platform carrying a capstan head on which the pouring device itself is mounted. The latter consists merely of an operating wheel and shaft, to the inner end of which, next to the die, is fixed a hot-metal reservoir terminating in a pouring spoon. The spoon is on the same axis as the operating wheel, by means of which it may be tilted, thus pouring the metal from the reservoir into the revolving mold.

The die or mold is cast iron, with an internal diameter corresponding to the external diameter of the ring to be cast. The outside diameter of the die is made to correspond with the internal diameter of the die-holder. The die or mold is usually about 1¼ inches thick, and the walls of the die-holder are 1 inch. However, these thicknesses are proportioned by experiment so that when making one casting every four minutes, the die is kept at a low red heat, about 550 degrees Cent., which has been found to be most suited to prolonging the life of the molds.

The general principles of permanent mold practice, originally developed by Edgar Allen Custer and others, are followed in making the castings, with such modifications as have been found necessary for centrifugal work. The castings are not left in the mold long enough for a chill to form. According to the practice of the Stokes company the castings are not annealed or tempered in any way, receiving no special treatment after they come out of the mold. This saves an operation. Nevertheless the castings are machinable all over. This is due to the careful chemical control of the mixtures, especially the content of silicon and manganese.

The die has a slight draft so the casting may be easily extracted. The castings is taken out with tongs, after the cover plate is swung out of the way, as shown in Fig. 11. In the experience of the Stokes company, special extracting mechanism has been found unnecessary.

As in all permanent mold work, some difficulty arises through the relatively short life of the dies, due to their developing cracks from the severe strains set up from alternate heating and cooling. As stated above, keeping the dies as nearly as possible at a constant temperature of about 550 degrees seems to be most satisfactory. The dies are each good for about 400 castings. They may be then bored out for larger castings, and thus a single die is made to serve for from 1000 to 1200 castings. The cost per casting is therefore moderate.

The rotating speed of the machine should vary with the size of the casting being made, from about 1500 revolutions per minute for a 4-inch ring down to about 800 revolutions for a 10-inch casting. Two factors govern the speed, first, the centrifugal force necessary to keep the hot metal in place and form a smooth casting, and second, the time lag between the moment the first metal enters the mold until it completes one circuit—that is the time for one revolution or lap of the metal—which must be short enough so there will be no cold shuts. This latter factor may be the more impor-

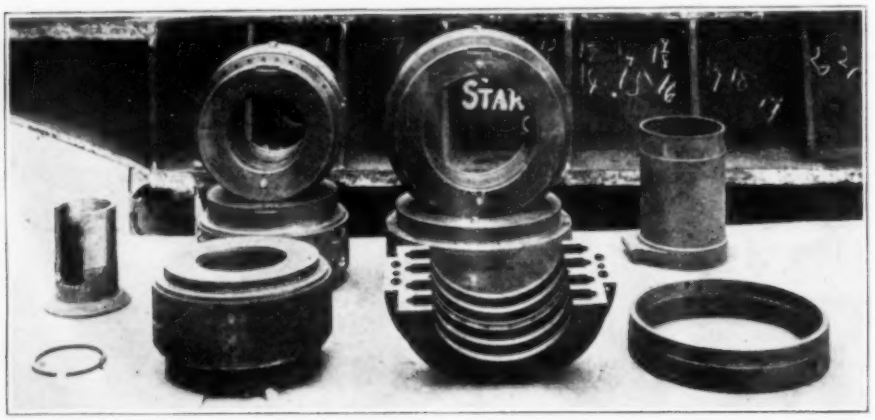



FIG. 12—SPECIMENS OF CENTRIFUGAL CASTINGS SHOWING VARIED NATURE OF PRODUCTS WHICH MAY BE MADE

tant of the two. For instance, in casting a 10-inch ring, the speed needed to generate enough centrifugal force to keep the metal in place is perhaps only about 300 revolutions, but the working speed has to be about 800 revolutions to avoid cold shuts.

In other words, centrifugal castings are formed, not by plain pouring and solidifying, but by wrapping the metal around the mold in strings like thread on a spool. The speed must be such that there will be no time for anything less than perfect fusion between the several laminations or threads of metal. If the process is properly conducted, the foundry scrap will not exceed 6 per cent and should perhaps average nearer 4½ per cent while the machine shop losses should be 3 per cent.

Four principal difficulties are encountered in making centrifugal castings, cold shuts, unformed ends on castings, pinholes and brittle metal. Cold shuts, as already suggested, are usually caused by running the machine too slow, or using cold metal. As in most other iron foundry operations, good hot metal is essential. Castings come out unformed at the ends if the die is too cold. Brittle metal results from using metal with the wrong composition. Pinholes, which are perhaps the biggest nuisance, may occur if the die is either too hot or too cold. A micrograph of a typical pinhole is shown in Fig. 9. All of these troubles result from improper practice and are readily avoidable.

### *How the Machine Works*

The process of making a casting in the Stokes type centrifugal machine consists of 13 principal operations, although the time required from the moment the metal is poured into the receiver until the casting is extracted is about a minute for a 6-inch piston-ring pot, or drum. However, the castings should be made at the rate of one every four minutes, which allows sufficient time for the subsidiary operations and prevents the mold from over heating. Semiskilled labor is employed by the Stokes company with good success. Each man is trained to his part of the job. The operations in making a casting are as follows:

1—Pour hot metal into receiver of pouring device
2—Start machine
3—Pour metal into the spinning mold
4—Dump residue of metal out of receiver
5—Let machine run and whirl casting
6—Stop machine
7—Unlock and pull off cover plate
8—Pull out casting with tongs, rapping if necessary
9—Blow out die with compressed air
10—Wash die with oil and graphite mixture; oil burns away
11—Insert spoonful of dry plumbago
12—Close and lock cover plate
13—Swing pouring device back into working position

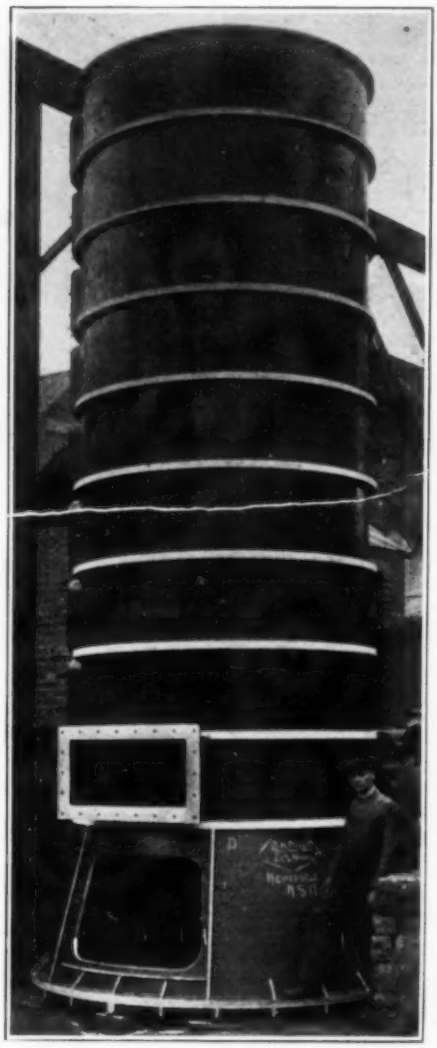


FIG. 13—GAS WASHER SHOWING BAYS OR SECTIONS ASSEMBLED

As with practically all other molding devices, the capacity of the machine is limited by the facilities for handling metal and arrangements for moving the finished castings out of the way. The machine itself is rapid, and since there is no sand to handle or ram, the whole process is speeded up.

### *Making Sand Castings*

The sand-casting department of the Union foundry is provided with standard equipment. A cupola with a capacity of 4 tons an hour is provided, together with a 10-ton traveling crane of 35-foot span, and a jar-ramming machine built by the U. S. Molding Machine Co., Cleveland, Ohio. This machine is equipped with a turnover pattern-drawing attachment.

Various kinds of gray-iron castings are produced. One of the specialties is bays or sections for centrifugal gas washers. The washers are built for Kirkham, Hulett & Chandler, London, with whom the Stokes company has been associated for many years. An assembled washer is shown in Fig. 13. This device, as indicated, is built up of a number of flanged circular sections resting on a base section. Each section has a flanged square manhole opening on the side. The largest bays are 7 feet outside diameter and 2 feet deep.

The casting is made in a green-sand mold, in a three-part flask. The drag, cheek and cope are shown respectively in Figs. 14, 15 and 16. The drag or bottom part of the mold is bedded in the floor on a coke bed to insure efficient venting. The three parts of the mold also are shown in Fig. 17, ready for assembly.

The pattern consists of a plain iron

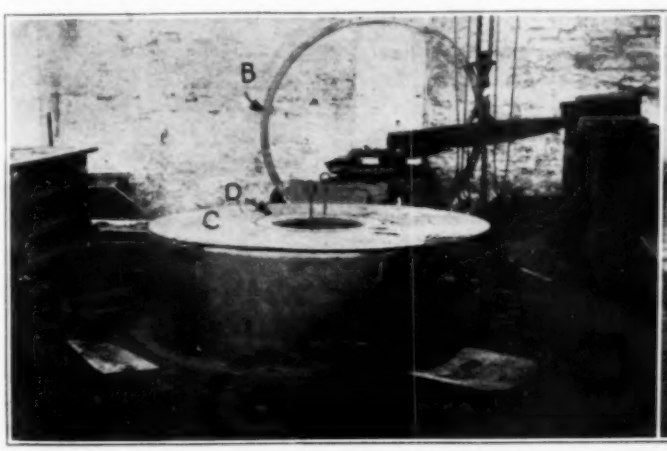



FIG. 14—BOTTOM OR DRAG PORTION OF MOLD FOR GAS WASHER SECTION

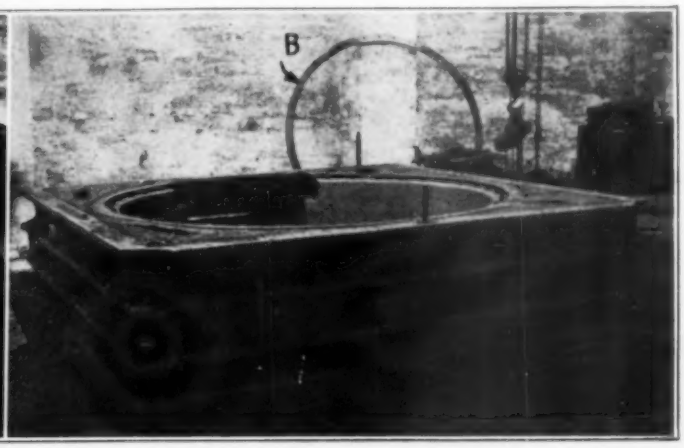
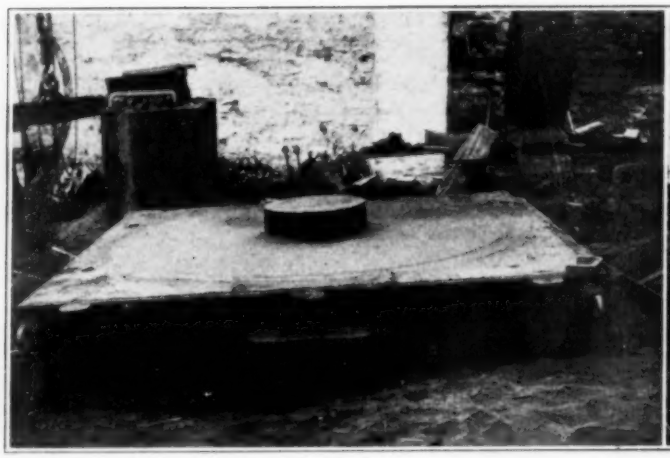



FIG. 15—CHEEK PORTION OF MOLD



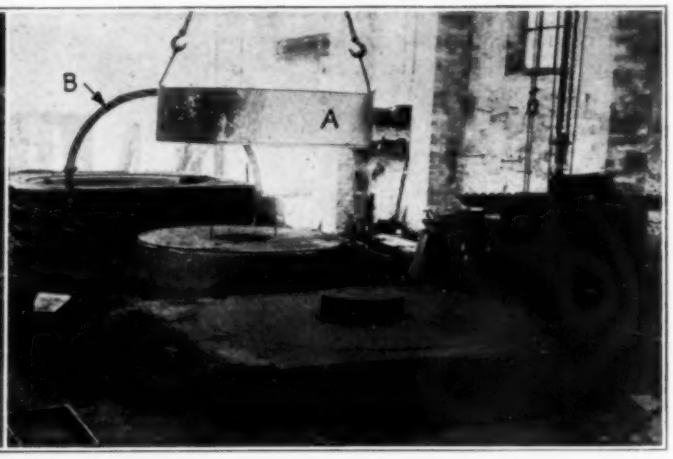



FIG. 16—A FLAT COPE IS USED FIG. 17—THE THREE PARTS OF THE MOLD READY FOR ASSEMBLY, SHOWING PARTS OF THE SIMPLE PATTERNS THAT ARE USED

ring shown at *A*, Fig. 17, with the two loose flange patterns, *B*. A large plain disc, *C*, Fig. 14, with the loose center bushing *D* forms the bottom of the casting. The square manhole opening in the side is made by a loose piece forming a core print. This core is shown at the left in Fig. 18. The connections between the sections also are formed by means of loose pieces.

### *Making The Mold*

In making the mold the bottom flange and main body pattern are first placed in position and the bottom, or drag part of the mold is rammed. This includes the sand inside the body pattern as shown in Fig. 14. The joint face is then struck off and parted flush with the floor. The cheek is then placed in position and rammed. After this is accomplished the top flange is set in place, sand being tucked around it and the parting made. The cope is next placed in position and rammed, the sand being held in place by gaggers. The cope can now be lifted off and the top flange and body pattern drawn. The cheek is next lifted off leaving the bottom flange clear for drawing. The mold is then finished and reassembled.

The casting is bottom poured through two down gates each of which connects with three finger gates attached to the bottom flange. These gates connect with two runners leading to a single pouring basin. Two risers are taken off the top flange. A sprue and the two risers are shown in Fig. 18. When this casting was first made in green sand considerable difficulty was experienced. This has been overcome by the gating arrangements described, and by uncovering the top of the casting as soon as it is poured, the center portion in the meanwhile being prevented from cooling too fast by piling on it the hot ends of risers, known locally as *hot heads*. This job is typical of the sand casting problems tackled by Stokes Castings Ltd.

Both the sand and centrifugal casting departments are under laboratory control. The metal mixtures are scientifically determined, and physical tests of the product are frequently made. Particular care is taken with the composition of the metal for the centrifugal process, as experience has shown that the success of this method of making castings depends to a great extent on strict laboratory control. This includes keeping track of the composition, moisture, etc., in the coke, to secure uniform melting conditions. The molding sand is also sampled every day, and tests are made to ascertain the bonding property and active clay content. The famous Mansfield sand is used in the foundry, this being one of the most widely known sands in England. The laboratory equipment includes a microphotographic apparatus.

### *Stable Working Force*

The working force being rather small, the labor problem is dealt with personally by the management and there is little difficulty. The labor turnover is exceedingly low. One of the men has been working at the Union foundry for 55 years and another, now of course no longer fully active, 60 years.

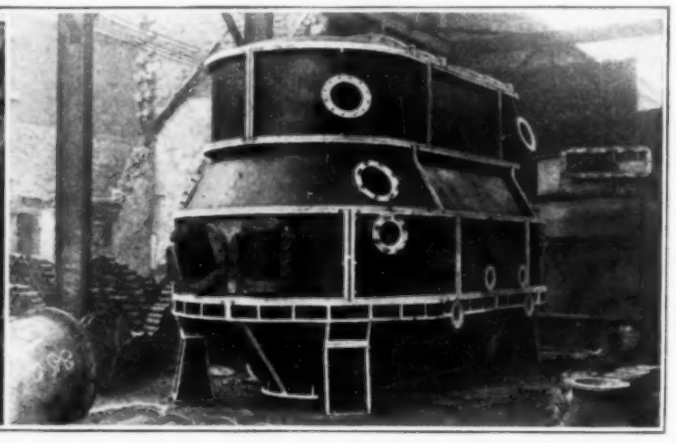


FIG. 18—THE CASTING AS IT COMES FROM THE SAND WITH GATES AND RISERS ATTACHED FIG. 19—ANOTHER TYPE OF GAS-WORKS APPARATUS MADE AT THE UNION FOUNDRY

(At the right) Saturator built for Simon Carves, Ltd., Manchester, for coke-oven plant of Indian Iron & Steel Co., Asansol, India, designed to extract the ammonia from the gas formed by the carbonization of 1500 tons of coal per day

# Loom Castings Tax Molder's Skill

## The Two Core Prints Were Attached To Strengthen the Pattern as Well as To Form a Seat for the Longitudinal Core at One Side and the Pocket Core at One End of the Intricate Casting Shown

BY H. R. SIMONDS

DESIGNING engineers connected with textile machinery manufacturing enterprises seem rarely to consider the foundry problems involved in producing some of the complicated parts entering into the construction of this class of machinery. The units are designed to occupy a definite place in company probably with thousands of others in a huge assembly and the designer feels that he has done all that reasonably could be expected when he arranges the parts so that the completed machine will function properly. He turns the drawings over to the foundryman and lets him do any necessary worrying. The casting for a shuttle box shown in the accompanying illustrations was refused by several foundrymen before it finally was accepted by a firm which molded it in the manner shown. It is made up of three long thin strips of irregular outline joined at the ends.

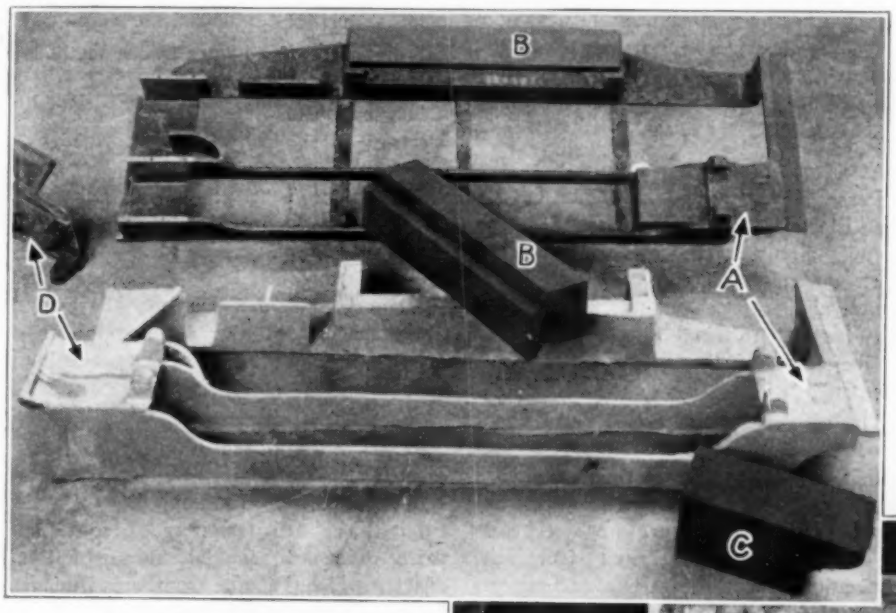



FIG. 1—THE LEFT HAND POCKET COVER WAS DOWELED ON SO THAT THE POCKET COULD BE FORMED IN GREEN SAND—A DRY SAND CORE WAS EMPLOYED TO FORM THE POCKET AT THE RIGHT HAND END

The successful solution of this problem was not due to any one factor, but to the combination of several, including ingenious pattern design, proper distribution of gates and the exercise of the utmost care on the part of the molder. The casting is poured *three-up* with hand ladles. One gate at the end is connected to the mold by a number of taps which distribute the iron simultaneously into the three longitudinal ribs. The other two gates are located on the joint between the wider pair of ribs and are connected to the ribs by four thin, flat branches on each side. The third rib is filled by iron which enters it at the bottom at each end and also to a slight extent from one tap on the end gate. The three strips shown connecting the pattern in Fig. 1, simply are reinforcing strips to prevent the ribs on the pattern from spreading and are stopped-off before the mold is closed.

By referring to Figs. 1 and 2 it will be noted that the pattern is designed to be molded in a 3-part flask. The mold is made altogether in green sand with the exception of the rectangular opening along one side and the single pocket at the right hand end indicated at *A*, Fig. 1, which are formed with dry sand cores *B* and *C* respectively. The cover plate *D* is made loose and fitted on with dowel pins so that the pockets at the left hand end may be formed in green sand by rolling the flask over twice. The pocket at the right hand end could have been formed in the same manner, but the construction would have weakened the pattern to a degree.

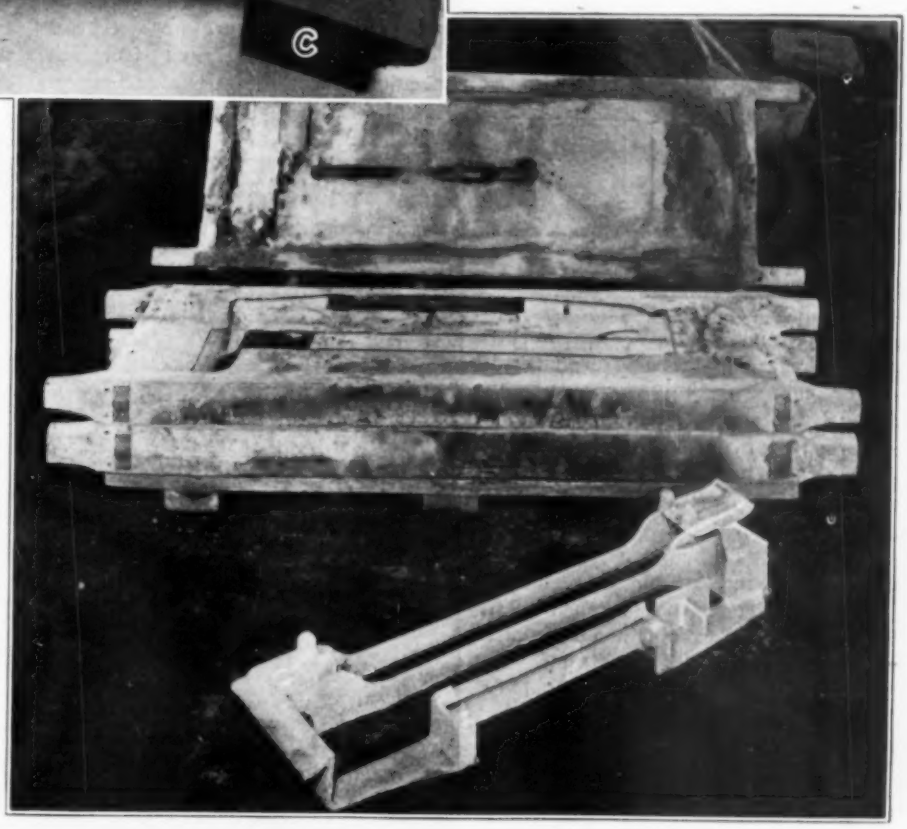


FIG. 2—THE MOLD WAS MADE IN A 3-PART FLASK AND POURED WITH THREE HAND LADLES THROUGH A NUMBER OF THIN, FLAT GATES

In making the mold the pattern is placed on a rollover board in the position shown in Fig. 1. The cheek flask is placed around it and rammed full of sand. It is scraped off flush, covered with a board and rolled over. The parting is made and a cope rammed in the usual manner. The cope is not lifted off at this point, but is clamped to the drag and both parts rolled over. The first board is removed and a parting is made down around the loose piece *D*. The drag part of the flask then is set on, filled with sand, rammed and lifted off. The loose piece of the pattern, *D*, is drawn out and after the exposed body of sand forming the pocket has been nailed along the edges, the drag is returned to place. The entire mold then is rolled over to the position it will occupy when ready to pour, after which the cope is lifted off, the pattern drawn, the cores set and the cope replaced as in any ordinary 2-part mold.

# Testing the Porosity of Molding Sand

KNOWLEDGE of conditions and the quality of materials entering into a manufacturing process are constantly being more strongly accentuated. Few foundries will now make castings without knowing the composition of the pig iron and scrap used in the cupola and many of them have the coke analyzed for sulphur. But the sand in the raw state or in the finished mold or core is seldom tested. This has been mainly due to the fact that no suitable tests have been developed which are

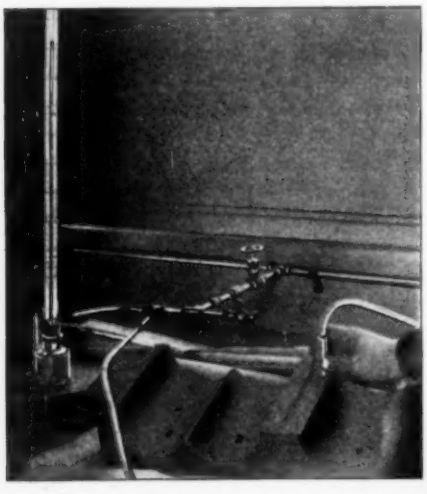


FIG. 1—APPARATUS FOR TESTING POROSITY

easily made and will give definite information regarding the sand or finished mold or core.

An instrument for testing quantatively the porosity of molds or cores has been patented by Carl Buberl, metallurgist, the D. J. Ryan Foundry Co., Ecorse, Detroit. The apparatus is shown in Fig. 1 connected to the air line. The pressure of air is regulated by a needle valve in conjunction with a relief valve so as to obtain a standard condition then the degree of porosity of the mold or core being tested is indicated on the calibrated gage shown to the left in Fig. 1 and to the right in Fig. 2. The higher the water rises in the gage the less porous is the specimen indicated to be as with a porous sample the air flows freely through the core and produces little back pressure. Fig. 2 shows the instrument attached to a small compressor instead of to the air line. This allows tests to be made in any part of the foundry regardless whether an air line is at hand or not. In this illustration a green-sand mold is being tested.

## Research Group Meets

At a recent meeting in Milwaukee the officers and operating representatives of the Electric Steel Founders Research group discussed reports on research work on annealing core practice, facing sands, and furnace and pouring practice. An inspection trip also was made to the plant of the Sivyer Steel Casting Co.

The research group was formed about two years ago for the systematic prosecution of co-operative technical work which could be directly applied to improving the manufacture of steel castings. The idea originated from the realization that the technical experts who direct the operating departments of steel foundries are prevented by their routine duties from concentrating all necessary research work. It was felt that the investigations could be carried on more effectively if they were under the direction of one individual who could co-ordinate the technical activities of a few plants whose methods and products are similar.

The members of the group are the Electric Steel Co., Chicago; the Ft. Pitt Steel Casting Co., McKeesport, Pa.; the Lebanon Steel Foundry, Lebanon, Pa.; the Michigan Steel Castings Co., Detroit; and the Sivyer Steel Casting Co. Milwaukee. The group's headquarters are at 639 Diversey Parkway, Chicago, where Major R. A. Bull, research director of the organization, maintains his office.

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The Whiting Corp., Harvey, Ill., has opened a branch office at 305 Merchants Bank building, Indianapolis. S. E. Stout has been transferred from the main office to assume charge of this district which includes southern Indiana and cities in Ohio and Kentucky.

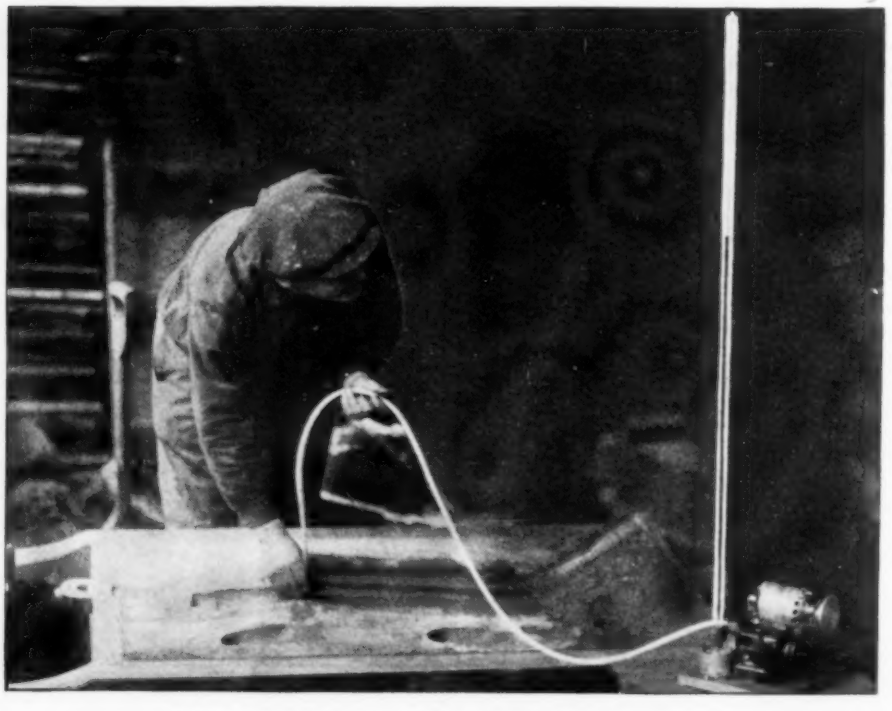


FIG. 2—METHOD OF USING POROSITY APPARATUS

# Uses Scleroscope on Thin Sections

## Samples a Quarter Inch Thick Give Accurate Results When Mounted by the New Methods—Low Readings Are Obtained When Samples Are Supported in Ordinary Ways

BY FRED S. TRITTON

SOME experience in the use of the scleroscope for testing the hardness of small pieces of metal in the laboratory led the author to doubt whether the real hardness values of small samples were obtained, although the usual precautions were taken to support the specimens in an apparently rigid manner. The experiments were undertaken with the view of finding out whether errors existed when using the ordinary methods of support and, if so, to find some method of support that would eliminate them.

The book of instructions issued by the Shore Instrument Co. shows that the importance of proper support of light samples is well recognized as essential if correct values are to be obtained. It also states that the specimen must be in the form of a cube weighing at least 1 pound before its inertia is large enough to resist the kinetic force of the falling hammer sufficiently to render the height of rebound independent of the mode of support.

Experiments made by the author show that hardness tests on underweight samples, carried out in the usual ways that are recommended, do not give results with the accuracy of which the instrument is capable.

As scleroscope hardness tests made on under-weight specimens have recently been used in scientific papers, the author desires, by the present preliminary paper, to show that caution should be used in placing reliance on the results of such tests. For the first experiment, two standard hardness reference bars, each weighing 14 ounces, were selected, having a hardness of 37-38 and 100-102 respectively. Marked areas of the surfaces were first tested in the ordinary way, and small pieces, which included the tested areas, were afterwards cut or ground from the block.

The size of the pieces cut out was 1 x 1 x ¼-inch, and their weight approximately 1 ounce each. In this way light specimens were obtained, whose scleroscope hardness was known from tests which were independent of the method of support. Every care was taken to make tests under the most favorable conditions possible. The under surfaces of the samples were machine ground, so as to be flat and parallel to the tested surface, which was left untouched. The scleroscope and, where possible, the surface of the sample were levelled with a spirit-level before each test. The same diamond-pointed universal hammer was used throughout the experiments. The scleroscope was a modern instrument with foot-clamp.

Paper presented at meeting of the British Institute of Metals held in Birmingham.

### *Tested in Advance*

The ends of the reference bars were chosen for experiments for various reasons, and were tested before cutting by placing the reference bar on end on a steel block and using the scleroscope on the swing arm. The following five consecutive readings were obtained:

| Bar 37-38 | Bar 100-102 |
|---|---|
| Bar No. 1 | Bar No. 2 |
| 37 | 99 |
| 37 | 102 |
| 37 | 100 |
| 37 | 99 |
| 37 | 98 |
| Mean 37 | Mean 99-6 |

A slice, ¼-inch thick, was then cut and ground from the end of the bars. Where grinding was necessary, great care was taken to prevent any heat being generated in the specimen. The small specimens so obtained were then supported in the various ways which are recommended and commonly used, and the hardness tested. The following results were obtained, five consecutive readings being observed.

Tested on base instrument with pressure on the clamp (ordinary test):

| Bar No. 1 | Bar No. 2 |
|---|---|
| 32 | 81 |
| 33 | 75 |
| 33 | 79 |
| 33 | 83 |
| 32 | 84 |
| Mean 32.6 | Mean 80.6 |

As compared with true value:

| 37-38 | 100-102 |
|---|---|

Specimens grippped in a vise with steel jaws. Tests were made in a straight line across the specimen, the first and last readings being close to the jaws of the vice:

| Bar No. 1 | Bar No. 2 |
|---|---|
| 29 | 67 |
| 28 | 63 |
| 26 | 60 |
| 29 | 65 |
| 30 | 70 |
| Mean 28-4 | Mean 65 |

In vise, using copper grips:

| Bar No. 1 | Bar No. 2 |
|---|---|
| 32 | 76 |
| 32 | 75 |
| 29 | 70 |
| 29 | 73 |
| 31 | 75 |
| Mean 30.6 | Mean 73.8 |

Pressed into plaster mount, maintaining a pressure on the clamp:

| Bar No. 1 | Bar No. 2 |
|---|---|
| 30 | 82 |
| 29 | 65 |
| 27 | 78 |
| 28 | 76 |
| 31 | 60 |
| Mean 29 | Mean 72.2 |

It will be seen that none of the ordinary methods of support gave results as high as those obtained from the bar before cutting, the greatest errors being found in the tests on the hard steel specimen. Other means of support were therefore tried, the procedure of the first successful method being as follows:

A small piece of pitch taken from the plaster mount is softened by holding in the fingers for a few moments; this is then applied to the bottom of the specimen to be tested. The sample and pitch are then placed in a screw clamp, such as that provided with the old pattern scleroscope, and screwed up slowly, allowing the pitch to flow from under the specimen until only a thin film remains; at this point further screwing becomes difficult and the sample is ready for test. Samples tested with this support gave values equal to those obtained from the reference bar. There were, however, objections to the use of this type of clamp, one being that only a small area could be tested without moving the specimen; also that, owing to the rotation of the

screw on the pitch, it was difficult to keep the sample in exactly the place required for testing.

A new type of clamp was therefore designed by Dr. W. Rosenhain, which eliminated these difficulties. Using this clamp with a layer of pitch beneath the

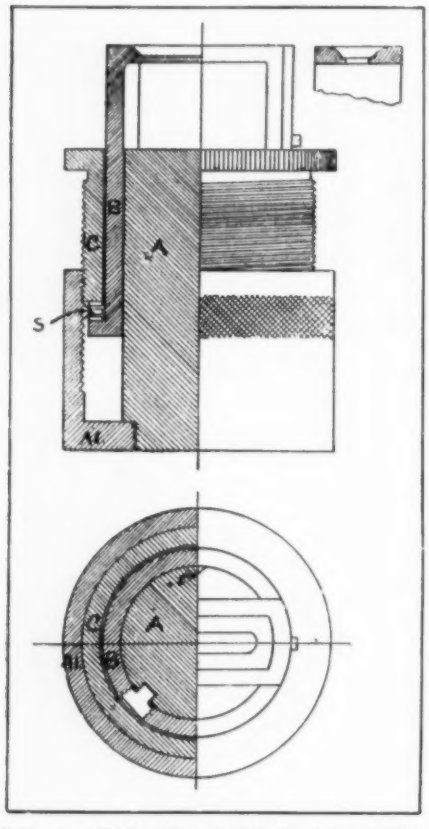



FIG. 1—CLAMPING DEVICE FOR THIN SECTIONS

specimens, the following rsults were obtained with the previous samples:

| Bar No. 1 | Bar No. 2 |
|---|---|
| 37.5 | 98 |
| 37 | 99 |
| 37.5 | 99 |
| 37 | 100 |
| 37 | 99 |
| Mean 37.2 | Mean 99 |

These results are almost identical with those obtained from the reference bars.

This clamping device is illustrated in Fig. 1; the maximum size of specimen which it is constructed to take is 1 inch high and 1⅜ inches wide. Fig. 1 illustrates the clamp fully extended; the base *A* is a solid cylinder of tool steel, to which is rigidly fixed the screwed part *A*1. Sliding closely on *A* is a sleeve *B*, the top part of which is cut away to form an arch. The sleeve is raised or lowered by means of screw *C*, which when screwed down applies pressure to *B*, and thus to the sample. Screwing must be continued until the film of pitch under the specimen is not more than 0.024-inch thick, otherwise correct results will not be obtained. The flow of the pitch is slow at this stage, and considerable pressure is required to cause further movement to take place at all quickly. The sample is now ready for test, the portion available for this purpose being that exposed by the slot in the top of the arch. This slot permits a line of tests to be made across the full width of the sample, and is broad enough to allow two tests to be made side by side. The original design for the clamp, which is shown in Fig. 1, has a strong spring, *S*, between the screwed part *C* and the foot of the sleeve *B*. It was hoped that by means of this spring a constant pressure could be kept on the sample, so that it would only be necessary to place the specimen and pitch in the clamp and screw up *C* until the spring was fully compressed, and the pressure of the spring would then slowly compress the pitch until the required thickness was obtained. However, it was found, that the interposition of this spring affects the rebounds of the hammer, and it has not been used in any of the experiments described in this paper, the pitch having to be compressed by constant hand pressure on the screw. The time taken to prepare the sample for test is 5 to 10 minutes, according to the size of the specimen and the amount of pitch. It is hoped that some form of spring may be found suitable, as the time taken in mounting the specimen by the present method is a disadvantage. The use of a pitch of low viscosity was found to be messy and inconvenient.

The effect of varying the thickness of pitch beneath the specimen is shown in Fig. 2, the real hardness number of the sample being 100-102. In this experiment, a thick piece of pitch was placed beneath the specimen and compressed slowly in the screw clamp. Scleroscope tests were made at intervals during this compression, the thickness of the layer of pitch being measured by means of *feeler* gauges, which were used between the top of the steel support and the bottom of the specimen, one side of which was left free from pitch.

The necessity of having a layer of pitch less than 0.025 of an inch thick, in order to obtain correct rebounds, led the author to experiment with other viscous substances, with the idea that perhaps the rigidity of the film alone might be sufficient to hold the specimen without the use of any clamp, thus leaving the whole surface of the sample free for testing purposes. Adhesive substances were first tried, the samples being attached to a hard steel block by means of various substances, such as Canada balsam, spirit gum, cellulose acetate dope, etc. These were allowed to dry or set, but, although good results were obtained with them, it was found that the time necessary for the material to set was too long for practical use. Attention was therefore turned to substances of high viscosity which would not set. A solution of glucose considerably stiffer than treacle was found to give excellent results. Using the previous samples attached by means of glucose to a hard steel base, the following results were obtained:

| Bar No. 1 | Bar No. 2 |
|---|---|
| 37 | 99 |
| 37.5 | 97 |
| 37 | 99 |
| | 99 |

The manipulation is simple and quick. The bottom of the specimen, which must be fairly flat, is smeared with glucose and pressed or wrung with a sliding action on to a flat-topped steel base, weighing at least 1 pound. The whole surface of the specimen is then perfectly supported for testing purposes. It is necessary to see that no air bubbles are trapped in the glucose beneath the specimen. The formation of these bubbles may be easily avoided by sliding the specimen about in all direc-

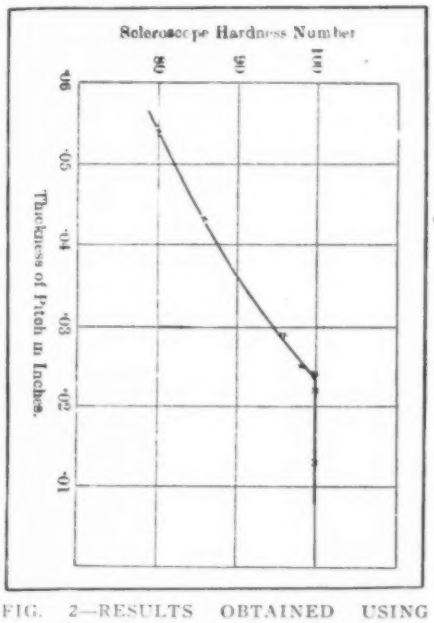



FIG. 2—RESULTS OBTAINED USING DIFFERENT THICKNESSES OF PITCH

tions on the support, until only a thin layer of glucose remains. Fresh glucose should continually be used, especially in dry weather. The use of stainless steel for the supports suggests itself, as they could be cleaned from glucose without being rusted by leaving them in water. The scleroscope can be used on the swing arm, but the old pattern stand is more steady.

The scleroscope can be fitted to the old pattern stand, and a specimen mounted with glucose on a hard steel cylinder for test. This arrangement

was found to be the most convenient

The great disadvantage of the glucose method of supporting the specimen is the danger of getting glucose on the hammer or the surface under test. This danger is reduced to a minimum if the specimens are mounted on a separate base. The preparation and removal of samples and their supports can then be done apart from the scleroscope, and there is little chance of the glucose getting where it should not be. The glucose can be removed from the specimen and support in a few minutes with water and, although there are doubtless other substances that would do as well as glucose, there are many advantages in using this common substance. The glucose used in these experiments was the ordinary liquid commercial variety having a specific gravity of 1.425. Where testing is only carried on intermittently, the glucose can be kept with advantage in an ordinary collapsible metal tube.

*Elasticity a Factor*

Another probable source of error that was suspected in the scleroscope test, is that the elasticity of the material supporting the specimen might affect the rebound of the hammer. In order to investigate this a number of metal bases were obtained whose scleroscope hardness and density were widely different. They were made in the form of cylinders whose diameter and height were equal. Each cylinder weighed 1 pound the following metals being used:

| Metal | Scleroscope Hardness |
|---|---|
| Hardened tool steel | 95-100 |
| Normalized tool steel | 35-36 |
| Aluminum | about 4 |
| Lead | 2-4 |

For these tests fresh specimens, having the same dimensions as the last, were obtained. The scleroscope hardness of the marked areas of the samples before cutting was 97-100 and 37-38.

The results of these specimens, when attached with glucose to supports of various metals, are shown in the following table. Three consecutive rebounds were observed.

| | Specimen | |
|---|---|---|
| | 37-38 | 97-100 |
| Cast lead support | 35 | 92 |
| | 35 | 91 |
| | 34 | 91 |
| Cast aluminum | 37 | 96 |
| | 37 | 96 |
| | 38 | 94 |
| Normalized tool steel | 37 | 98 |
| | 36 | 97 |
| | 37 | 99 |
| Hardened tool steel | 37 | 98 |
| | 37.5 | 98 |
| | 37 | 98 |

The results show that the rebound of the hammer is slightly affected by using different metals to support the specimens, even when the specimen is a quarter of an inch thick. Some experiments have been made with samples of metals 0.05-inch thick, but the results showed that the problem of testing thin sheet is complex, and much further work would be necessary before the results could be understood, one peculiar point being that higher rebounds were consistently obtained when using the lead support than when using any of the other metals, thus completely reversing the order obtained with the thicker specimens.

The results of the experiments show that the usual methods of supporting light specimens of metal for the scleroscope test do not give results with the accuracy which can be obtained when the specimens are supported by the methods that have been described. The first method is only applicable to specimens having two flat parallel surfaces, but the second method could be applied to specimens having curved surfaces, such as balls or rollers, providing that a recessed support is made to fit them.

## Sand Association Protests Freight Rates

At the annual meeting of the American Sand association, held recently, the following officers were elected for the ensuing year: President Theodore B. Ely, Venango Sand Co., Franklin, Pa.; first vice president, W. H. Smith, Superior Sand Co., Cleveland, O.; second vice president, E. E. Klooz, Portage Silica Co., Youngstown, O.; secretary and counsel Hubert B. Fuller, Cleveland, O.

The association is now endeavoring to have the freight rates reduced on silica, molding and other industrial sands. Late last fall the carriers of the Central Freight association filed with the interstate commerce commission new tariffs of interstate rates intended to lower freight rates on building sands, but expressly excepting other industrial sands. The American Sand association filed a protest contending that the uses to which the sand is put are not transportation factors and therefore have no place in determining rates and classification. A hearing was granted to F. R. Thrall, Geauga Silica Sand Co., Cleveland, and Hubert B. Fuller, representing the association. It is understood that a decision is being held pending the outcome of the general rate hearing now being conducted by the interstate commerce commission.

The Detroit office of the Whiting Corp. has been moved from the Penobscot building to 206 Stahelin building, 3000 Grand River avenue.

## Castings Export Figures To Be Given

Under a new classification of iron and steel exports, monthly statistics of the bureau of foreign and domestic commerce are available which give figures showing the tonnages of castings shipped to purchasers in foregin countries. The January, 1922, statistics include 72 tons of malleable iron castings, 377 tons of other iron castings, 363 tons of steel castings and 2210 tons of car wheels and axles.

Exports of cast iron pipe in January were 821 tons and of cast iron pipe fittings 415 tons. Malleable iron pipe fittings exported in the month were 792 tons.

## British Foundrymen to Visit America

Accepting the invitation of the American Foundrymen's association, Oliver Stubbs, president and Thomas H. Firth, past president of the Institution of British Foundrymen, will sail for America, April 8 on the Steamer SCYTHIA for an extended tour of the United States and Canada. During their visit in the United States, which will extend until about June 1, Mr. Stubbs and Mr. Firth will visit the large foundry centers of the eastern and central states. It is probable that they will be unable to remain for the American Foundrymen's association convention and exhibition in Rochester during the week of June 5, owing to the opening of the British foundry exhibition in Birmingham which is to be held the week of June 19.

Mr. Stubbs is joint managing director of Joseph Stubbs, Ltd., iron founders and manufacturers of textile machinery in Manchester, England. Mr. Firth, who was elected president of the Institution of British Foundrymen in 1918, has been prominent in the activities of that society for a number of years. He is manager of the Brightside Foundry Co., Ltd., Sheffield.

## Organize New Company To Sell Refractories

F. W. Reisman and L. E. Turk, formerly sales manager and treasurer respectively for the Quigley Furnace Specialties Co., New York, have with others organized the Keystone Refractories Co. with offices at 120 Liberty St., New York. The company plans to manufacture high temperature cement and granular refractories at its plant in Jersey City.

# How and Why in Brass Founding

By Charles Vickers

## Mixture for Bronze Valves for Paper Mills

*We would like a mixture for bronze valves to be used on pulp digestors in paper mills. We recently supplied some nickel base alloy castings for this purpose, and were surprised to note they failed before our standard bronze consisting of copper, 86 pounds; tin, 6 pounds; zinc, 6 pounds, and lead 2½ pounds.*

*The nickel alloy lasted only ten days while the bronze lasts 14 days. The valves are in contact with hot sulphurous liquids and gases.*

It is doubtful if any bronze will be satisfactory in this kind of service. The following alloy is worth a trial as it may be an improvement over the bronze that has been in use.

ANTI-ACID BRONZE

| | Pounds |
|---|---|
| Copper | 75.00 |
| Tin | 10.00 |
| Lead | 15.00 |

When the copper is charged, place 2 ounces of phosphor copper in the bottom of the crucible, to deoxidize the copper as it melts. Thoroughly stir the alloy before pouring.

## Machine vs. Hand Molding

*We are making small castings of aluminum using scrap chiefly, but have trouble when we make them on a hand molding machine, although the castings are satisfactory when made by hand ramming. The molds made on the machine, chiefly the ones with cores, blow and boil and even throw the metal out two or three feet into the air. We have never had any experience with machine molding, and apparently the machine molds are not rammed as hard as the hand rammed ones. What are your suggestions?*

If the machine made molds are rammed softer than the hand made molds, then the sand used for the machine is too damp; in fact it is not merely damp, it is wet and something is radically wrong somewhere.

If the cores will blow in a machine-made mold they will blow just the same in a hand-rammed mold. Our suggestion is to have someone that can be trusted watch all the time the molds are being put up on the molding machines, to make sure the machines get a square deal. The cause of the trouble is wet sand, hard ramming, hard cores, or unvented cores; or a combination of all these causes applied to the machine product and not to the hand-rammed product.

## Fluxes for Aluminum Will Not Cure Porosity

*We have been using scrap aluminum in our mixtures, but have had complaints of the castings being porous. What flux can we use to overcome this difficulty?*

The flux generally used in melting aluminum is chloride of zinc. A comparatively small amount is required, a piece the size of a walnut being sufficient for a crucible of molten aluminum. Use the fused zinc chloride and keep the same in well sealed containers. Add the zinc chloride a few minutes before the aluminum is ready to remove from the furnace. Simply throw it upon the surface of the metal, then stir it around. This flux, however, will not prevent porosity. This latter fault is due to overheating the aluminum in the furnace and more particularly to pouring it into the molds at too high a temperature. Pour the aluminum at as low a temperature as possible to run the castings, and never allow it to get above a red heat while in the furnace.

## Valve Metal Formula for Gasoline Pumps

*We would like to have a formula for gasoline pump valves. We have been using an alloy of copper, 90 per cent; tin, 10 per cent, but this is not sufficiently hard to suit our customer.*

The following alloy is suitable, but if any more complaints are heard about its being too soft, simply increase the tin, and decrease the copper a like amount.

ALLOY FOR PLUNGERS AND VALVES

| | Pounds |
|---|---|
| Copper | 86.0 |
| Tin | 8.0 |
| 5 per cent phosphor tin | 2.5 |
| Zinc | 2.0 |
| Lead | 1.5 |

## Nickel Alloys for Ice Cream Machines

*We are called upon to make castings of an alloy called nickel silver and desire to know if this is the same as German silver. The formula we have been given consists of copper, 50 per cent; nickel, 15 per cent; zinc, 32 per cent, and tin 3 per cent. Another suggested formula follows: Copper, 33 per cent; nickel, 33 per cent, and zinc, 33 per cent, which is a long way from the first formula. The castings are for use on power ice cream freezers to replace tinned or nickel plated bronze and a white color is desired. Any suggestions will be appreciated.*

The first mixture mentioned usually contains 35 per cent of zinc, and 2 ounces of aluminum per hundred pounds. Probably this mixture would fill the requirements. It is known as Victor metal. If an alloy as white as nickel is required, the following will be suitable:

WHITE NICKEL ALLOY

| | Per cent |
|---|---|
| Copper | 65.00 |
| Nickel | 32.25 |
| Aluminum | 2.75 |

To make the above alloy melt the copper and the nickel together under a covering of charcoal, then add the aluminum. Alloys of copper, nickel and zinc, with or without small amounts of iron, or aluminum are known as German silvers, and also as nickel silvers. Aluminum should not be added for castings to be subjected to pressure. If trouble from porosity is experienced with these nickel-copper alloys add about 3 ounces of manganese copper to each hundred pounds of nickel silver, as a deoxidizer.

## Aluminum Piston Mix

*We would like to get a good mixture for aluminum pistons.*

A good mixture for aluminum pistons is an alloy of copper 12 per cent; aluminum 88 per cent. Make it by using a hardener of copper and aluminum in the proportions of 50 per cent of each metal.

Melt together 24 per cent of the 50-50 hardener and 76 per cent of aluminum, and pour as cool as is possible.

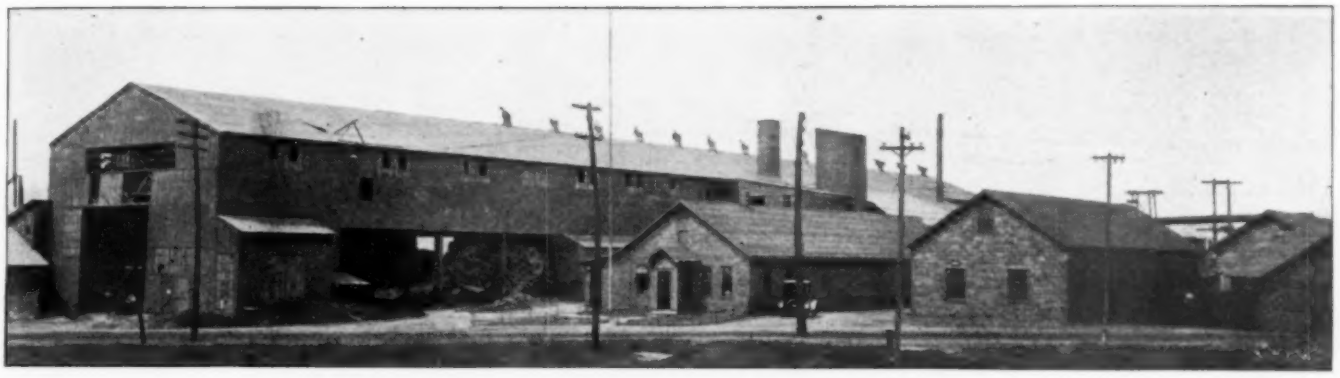


Fig. 1—The original foundry as it appeared before the addition was built on the back

# How Ingot Mold Castings Are Made

DISSATISFACTION with the quality of steel made by the cementation process a hundred years ago led a clockmaker in the north of England to cast about for some method of securing homogeneity. He reasoned that the bars of iron placed in a heating furnace with some carbonizing material did not absorb the carbon uniformly and the only method to secure the desired result, and to diffuse and incorporate the elements thoroughly would be to melt the iron after it had been carbonized. This method was pursued for some time with gratifying success and naturally was guarded with the greatest care. The blister steel, cut into short lengths, was placed in a small clay crucible and subjected to intense heat in a furnace of the pit type. After the charge had melted, the crucible was lifted out and placed to one side until the contents had cooled; the crucible then was broken and the resulting block or ingot of steel was broken down under the hammer and rolled into any desired shape. The method kept pace with the demand for some time, since the use of steel was limited to the manufacture of cutlery, springs and small instruments; but with the introduction of the bessemer process in 1855 and the open-hearth process of making steel a few years later, it became necessary to devise some other means of handling the molten steel. The principle of casting the steel into a solid block to preserve homogeneity was recognized and appreciated as being essential to success, irrespective of the shape the steel finally was to assume; but it was utterly out of the question to think of pouring the steel into clay pots to cool as had been done previously.

Cold blast iron low in phosphorus and sulphur and, therefore, peculiarly adapted to the manufacture of steel by the bessemer process, also was available for the manufacture of the first cast iron ingot molds. This fortunate combination of circumstances undoubtedly exercised a considerable influence on the rapid adoption of the bessemer process of making steel. Had the foundrymen of that period been confronted with the problem of making ingot molds from basic iron it is probable that the manufacture of steel on an extensive scale might have been delayed to a considerable extent. Ingot molds made from what is known in this country as bessemer iron, either direct metal or cupola melted, usually are good for over 100 heats. In fact ingots showing a life of 150 to 200 heats before they have to be scrapped, are not uncommon. Ingot molds made from iron not having the peculiar properties of bessemer iron, frequently split from top to bottom in service with their first steel ingot.

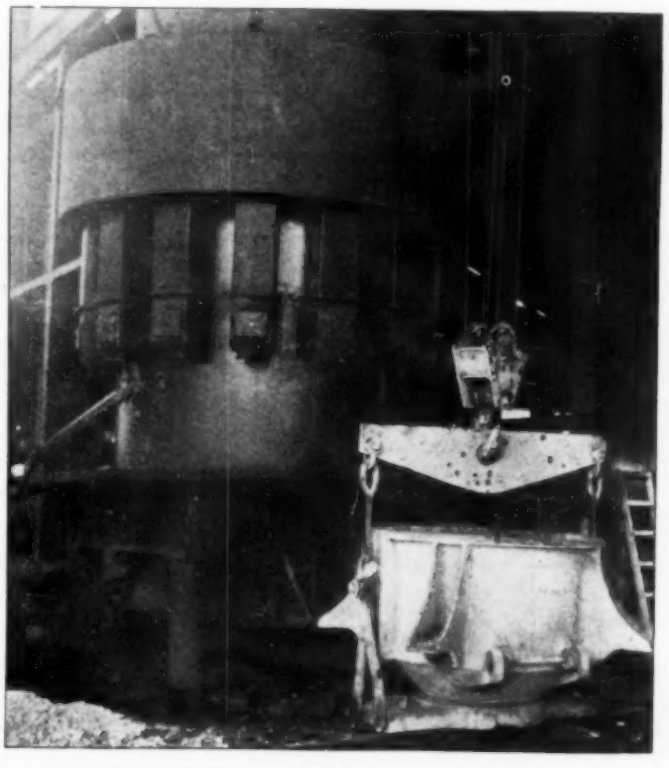


FIG. 2—EACH TUYERE IS PROVIDED WITH A DAMPER FOR REGULATING THE INTENSITY OF THE BLAST AT ANY GIVEN POINT—COKE FOR EACH CHARGE IS MEASURED IN A STEEL BUCKET

From the forgeoing it is apparent that the life of the ingot mold is an important factor in determining the cost of making steel. For instance an ingot mold costing $100 and remaining in service until 500 tons of steel have been poured into it might be said to have added 20 cents a ton to the cost of the steel. However, after it has served its purpose, it still represents the value of its weight in scrap, frequently half of its initial cost, and therefore the actual ingot mold cost to be charged against the steel will not exceed 10 cents a ton. Contrasting these figures with the cost entailed by employing molds that only last for a few heats explains why only the few steel companies fortunate enough to be operating one or more blast furnaces on bessemer iron, attempt to make their ingot molds for their own service. The greater number of the

FIG. 3—A MAGNET SUSPENDED FROM THE CRANE IS EMPLOYED TO MAKE UP THE PIG IRON CHARGES IN THE STEEL BUCKETS—EACH BUCKET HOLDS 10,000 POUNDS

ingot molds made in the United States are poured from direct metal, that is metal as it comes from the blast furnace. As already stated, some of the larger steel companies, equipped for making converter steel and therefore producing bessemer iron from one or more of their blast furnaces, divert some of the iron to their ingot-mold foundry. Almost the entire product of several independent blast furnaces is converted into ingot molds and other castings of a like character. Others, again, convert part of their output into pig iron and sell the remainder in the shape of direct metal to independent foundry companies in the vicinity engaged in the production of ingot molds and other castings for which bessemer iron is essential.

*Foundry on Double Turn*

The Hanna Furnace Co., probably the largest producer of merchant pig iron in the United States, operates stacks in various places including Buffalo, Detroit, Cherry Valley, and Dover, O. The furnace at Dover has a capacity of 500 tons a day of which approximately 250 tons is taken by the Penn Mold & Mfg. Co., an independent foundry company, which converts it into ingot molds and stools. The foundry was established in 1917 and was operated 24 hours a day, the same as the blast furnace, taking two ladles of iron every tap until the recent depression in business began. The blast furnace was blown out for a general overhauling about a year ago and since that time the iron for the molds has been melted in a cupola lined to 66 inches. The iron and coke charges have been taken up to the charging platform on an electrically operated elevator and thrown into the cupola by hand. Even when operating on a reduced schedule and on single turn the large quantity of material to be handled required the services of 14 men. To reduce operating expenses and also to meet anticipated increased customers requirements until the blast furnace once more is in condition to furnish direct metal, the company recently built an extensive addition to the foundry building and installed a new cupola of greatly increased capacity.

The new building parallels and adjoins the former structure for almost its entire length and the general construction features are the same in both cases. A heavy steel frame, designed to carry a constant succession of large and heavy loads 24 hours a day, supports a high roof, which together with the walls, is covered with corrugated iron sheets. The heat radiated from the molds and castings while the shop is in operation renders any form of artificial heating system unnecessary. In fact for the greater part of the year the roof covering over the shake out and cleaning department and also sections of the wall covering in the same vicinity are dispensed with altogether.

Part of the new building before the roof or side walls were covered, is shown in Fig. 4. The new cupola stands and is charged in this part of

FIG. 4—NEW ADDITION TO THE FOUNDRY BEFORE THE ROOF AND SIDE WALLS WERE ENCLOSED

the building, but the spout projects into and delivers the iron into the old part of the foundry adjoining. Many original innovations and others perhaps not original, but adapted in an original manner, characterize this cupola which was built and erected by the Whiting Corp., Harvey, Ill. The first outstanding feature which strikes a foundryman's eye is the entire absence of anything in the shape of a charging platform. Another is the gap between the top of the shell and the smoke-stack hood suspended above it. A unique method of charging the cupola through the top in the same manner as a blast furnace, is responsible for this type of cupola, a method by which 4 men can handle a considerably larger tonnage in this 72-inch cupola than 14 men could handle in the 66-inch cupola in the old shop.

The building is spanned by a 30-ton crane made by the Morgan Engineering Co., Alliance, O. In addition to the main hoist, the crane is provided with a 10-ton auxiliary hoist which is used for a variety of purposes including that of charging the cupola. Pig iron is brought in on railroad cars on the track shown at the extreme left of the illustration. It is unloaded either on to the ground or directly into the charging buckets, depending on circumstances, by a magnet from the auxiliary hoist of the crane. Instead of being controlled from the cab of the crane, the magnet is energized and released by a cable extending from one of the columns close to the pig iron pile. A man stands close to the column and controls the action of the magnet simply by throwing a switch in and out. The advantage claimed for this method is that the magnet and controlling apparatus form a unit and as soon as the crane is needed for some other purpose the magnet can be thrown off the hook as readily as a chain or any other piece of equipment. There is no dangling cable to be taken care of. Similarly, when the time comes to use the magnet, it is necessary only to throw the suspension loop over the crane hook.

FIG. 6—JACKETS ARE SET OVER THE OPEN HOLES ABOVE COKE FIRES AND DRIED IN AN AVERAGE OF TWO HOURS

### *Steel Charging Buckets*

The cast-steel buckets employed for charging the cupola are shown in Figs. 2 and 3. By referring to the two illustrations, it will be noted that while the body of the coke bucket shown in Fig. 2 is similar to the pig iron buckets shown in Fig. 3, the bottom is constructed in a different manner. One beam and pair of slings handles all the buckets in turn and one crane man can keep the furnace charged to the top even when it is melting at its maximum speed of 20 tons an hour. Each bucket load constitutes a charge. The pig iron buckets hold 12,000 pounds each and the coke bucket holds 1200 pounds of coke and 11 shovels or approximately 300 pounds of limestone.

The crane operator lowers the bucket close to the coke and limestone piles where two men fill it by hand. It then is picked up as shown in Fig. 2 and hoisted directly over the open top of the cupola. Here it is lowered until the four double brackets, or feet, come to rest on the shell. By slacking off on the hoist the hinged bottom opens and spreads apart and thus automatically discharges the contents. When the strain once more is put on the crane the toggle jointed connections on each side elevate the body of the bucket and pull the two halves of the bottom together again. It is claimed that the tapered construction in the bottom of the bucket distributes the coke in a more satisfactory manner than if the opening were straight as in the case of the pig iron.

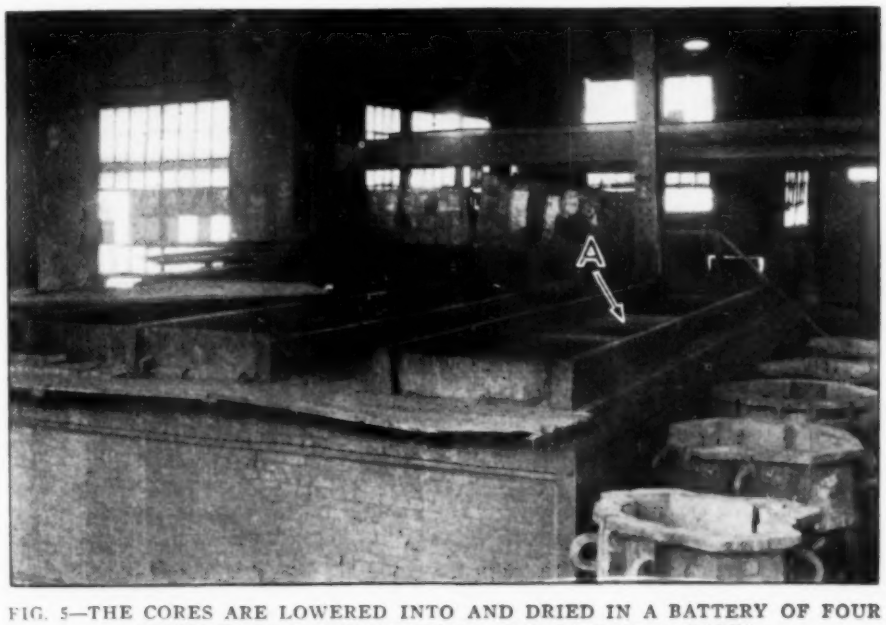



FIG. 5—THE CORES ARE LOWERED INTO AND DRIED IN A BATTERY OF FOUR OVENS EACH OF WHICH HAS A CAPACITY OF 10 CORES

### *Charges Are Measured*

The crane is employed both to load the pig iron buckets and to dump them in the cupola. That is one of the reasons the magnet is controlled from the floor rather than from the crane cab. The instant the buckets are filled, the magnet is dropped to be replaced by the beam and slings used for lifting the buckets. The coke is now weighed by the bucketful, but each bucketful of pig iron and scrap is weighed on a Fairbanks scale shown in the center background Fig. 3, before it is hoisted over the top of the cupola. Minor adjustments to the weight of the charge may be made

at the scale, but the man operating the magnet and loading the buckets soon develops the ability of estimating the charge so that no adjustment is necessary. Scrap, gates, runners, etc., are piled in a concrete lined pit extending almost all the way across the center of the floor as shown in the illustration Fig. 4. When it becomes necessary to use a portion of the scrap in the charge, a small quantity of ferrosilicon is added also to compensate for the loss in the scrap.

The cupola is constructed along the general lines adopted on cupolas used with bessemer converters which sometimes are operated continuously day and night for a week at a time. The shell, 120 inches in diameter, carries a 24-inch rock lining. This gives a melting or working diameter of 72 inches. The windbox encircling the shell supplies air to 15 pendant tuyeres. By referring to the illustration it will be seen that the tuyeres are set fairly close together on the outside. Since they are on radial lines it is apparent that this arrangement results in a practically continuous tuyere on the inside. The bottom edge of the tuyeres is 52 inches above the sand bottom. With such a deep hearth, it is possible to draw off 12 tons of iron at one tap. The blast is furnished by a positive pressure blower made by the Piqua Blower Co., Piqua, O., driven by a 75-horsepower, variable-speed motor. By regulating the speed of the motor, the rate of melting may be accelerated or retarded to meet operating conditions in the foundry. Each tuyere is provided with a damper to be used in case a tendency to bridge should develop at any point in the melting zone. After each tap, the cupola tender walks around and peeps into each tuyere. If he finds one or more going *black* he shuts it or them off until the time for his next inspection when he will find that the black area once more is red and bright. The iron is melted fairly hot, but no attempt is made to secure white hot smoking metal. In fact it is claimed that metal poured a little on the cold side produces the best quality of ingot molds.

Commencing at one end of the foundry where the sand is mixed, the work moves in an uninterrupted straight line to the other end where the castings are cleaned and shipped. Two sand mixing units made by the Standard Sand & Machine Co., Cleveland, supply all the sand required for approximately 30 molds and cores made on each shift, besides the stools and miscellaneous repair and jobbing castings made in a side bay of the foundry. The sand mixers are installed in a leanto extending across the full width of one end of the building.

FIG. 7—THE MOLDS ARE ASSEMBLED FOR POURING IN A SHALLOW PIT ON BOTH SIDES OF A POURING PLATFORM

A rather coarse grade of Zanesville sand is employed. This is mixed in the proportion of 1 to 10 for the jackets and 1 to 9 for the cores. Side dump cars, running on a narrow gage track and propelled by a small gas-burning locomotive convey the sand from the new sand storage shed and from the shakeout floor in the foundry to the mixers. Formerly the new sand was kept in a building at the opposite end of the foundry from the sand mixers. However, a standard gage track, elevated on a trestle has been extended to connect with the end of the building in which the sand is mixed. The sand is delivered in drop-bottom cars and is discharged through the trestle. It is shoveled into the side dump cars by hand. The old sand is loaded by a grab bucket suspended from one of the cranes. The car is lifted from the track and set down where the sand is most plentiful. After it is loaded it is picked up by the crane and set back once more on the track.

The old and new sand is dumped into a screen-covered hopper below the track level. From the hopper it is taken by a bucket elevator and discharged into a mixing pan and riddle. A workman attending the mixer adds enough water from a spraying device provided for that purpose, to give the sand a good working bond. No artificial bond of any kind is added. From the discharge spout of the mixer, the sand falls upon a wide belt which deposits it in a pile on a comparatively wide platform about 6 feet above the floor level and extending all the way across the building.

The ramming gang, three men on molds and three men on cores, stand on the platform, a position which brings them on a level with the tops of the flasks and core arbors which are lined up in a row on the floor all the way across the front of the platform. Two men ram the sand in each case while the third shovels. Long-stem pneumatic rammers suspended from the end of a swinging jib and attached to a long counterweighed cord are employed for ramming the jackets, but, while the same equipment is provided over the core ramming end of the platform, the men prefer to ram the cores by hand. Five ramming bases are provided and as fast as the men finish ramming one jacket they move on to the next. As they move along, the rammed jacket is removed by the crane and replaced by another empty one. This sequence, which also applies to the cores, is repeated until the men have rammed their quota of 30 or more. Before the flasks or core arbors are set on their respective ramming bases, they are dipped in a circular iron tank about 10 feet deep set into the floor and filled with water. The tank is provided primarily to cool the flasks and arbors which are stripped from the castings within 2 hours after they are poured. In addition to this wetting which assists the sand to cling to the iron surface, the core arbors are given a light coating of claywash before they are enclosed in the corebox. The coreboxes are split vertically along one corner and are held together by suitable hinges and catches.

The molds and cores are blacked with a special ingot-mold blacking

## ROUTINE ANALYTICAL METHODS

(*Concluded from Data Sheet No.* 420)

### DETERMINATION OF COMBINED CARBON

The most widely applicable method of determining combined carbon in gray iron is to subtract per cent graphite from per cent total carbon. The microscopic determination has been advocated as quite accurate, but because of differences according to depth of section and the presence of phosphorus-rich areas this method cannot be recommended for general work although it is quite useful in certain cases. A valuable method for routine work on *normally* cooled gray iron is the color method.

*Principle*—This method is based on the fact that nitric acid does not dissolve graphite, but attacks iron and manganese carbides and is colored by them in direct proportion to the amount of carbon combined. The method is accurate to 0.02 per cent on normalized structures. The same sampling precautions must be observed as in graphite determination.

*Procedure*—Weigh out a 0.1 gram sample of iron to be tested and 0.1 gram of standard iron of known combined carbon content, in two 6 x ⅝ inch test tubes. Add 5 c.c. 1.20 sp. gr. nitric acid. Cover with a marble and place in water bath. Heat at boiling point until all evolution of gas has ceased. This requires 1½ to 2 hours. Cool and filter through a 7 cm. *dry* filter paper into another set of tubes, washing the original tube and the filter. Transfer the solution of the standard to one of the comparison tubes and dilute to some multiple of its combined carbon content. For instance, if the standard contains 0.55 per cent combined carbon dilute it to 11 c.c. or to 16.5 c.c. Transfer sample to be tested to the other comparison tube. Thoroughly mix the solution in each tube. Progressively dilute the sample to be tested mixing thoroughly after each addition of water, and comparing with the standard until its color exactly matches that of the standard. The number of c.c. to which the sample has been diluted to attain this point, divided by the multiple to which the standard was diluted gives the percentage of combined carbon. For instance, a standard containing 0.55 per cent combined carbon is diluted to 11.0 c.c. (20 × 0.55) and if the sample to be analyzed must be diluted to 10 c.c.te match the standard, the sample then contains 0.5 per cent combined carbon (10 divided by 20). If the standard is diluted to 16.5 c.c. the divisor is 30. If the unknown sample has a different cast to the brown than is produced by the standard, it is better to check by direct determination of graphite, as this difference in color signifies that the combined carbon is not in the same combined condition in the two samples. This rarely occurs in gray irons, but is notorious for steels where the transition forms between cementite or pearlite and austenite, such as troostite and sorbite or martensite, are found.

*Notes and Precautions*—Combined carbon of the standard should be approximately that of the sample.

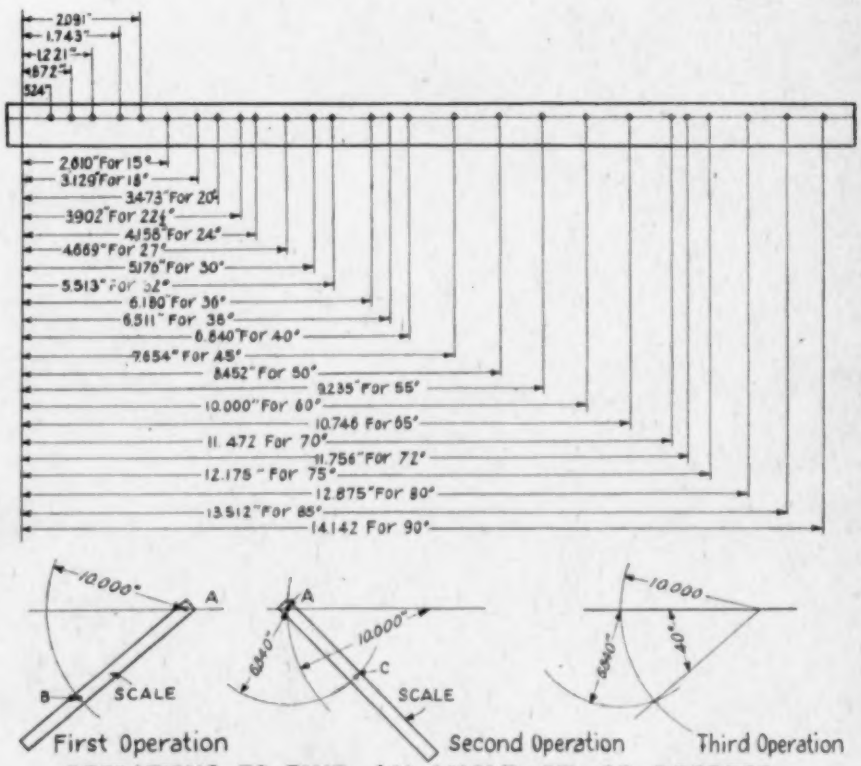
The standard should be diluted to at least twice the original amount of acid to destroy the color of ferric nitrate.

Copper, chromium, hydrochloric acid and transition forms of iron carbide make true comparison not possible. Exposure to sunlight or long standing destroys color.



## METHOD FOR LAYING OUT ANGLES

*By Arthur McAlpine*




**OPERATIONS TO FIND AN ANGLE OF 40 DEGREES**



Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form

THE FOUNDRY DATA SHEET, MARCH 15, 1922

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

and then they are well dried before they are assembled. The cores are dried in ovens, but the jackets are dried by confining the heat on the inside. Formerly the jackets were dried by setting them on two parallel rails supported about 2 feet from the floor on concrete piers. The flame from a gas main underneath was directed up into each mold through a suitable opening. Recently the supply of gas has not been adequate especially in the winter. The service has been discontinued and now the molds are dried over the coke fired device shown in Fig. 6. This comprises a battery of eight individual fireplaces covered with cast iron plates, each one provided with a round hole through which the heat from the fire enters the mold. A piece of steel ½ inch x 1 inch on each side of the hole prevents the bottom sand surface of the mold from coming in contact with the hot cover plate. Molds are dried in this manner in about 2 hours time and in a satisfactory manner.

The cores are dried suspended in the battery of four ovens shown in Fig. 5. The fireplace is set at one end of each oven and the chimney connection is located at the other end. Suitable openings in the floor of the oven permit the heat to rise and circulate among the cores. Pipe rollers shown at *A*, Fig. 5, extend across the top of each oven and engage a device provided with a double hook from which the core is suspended. Each oven has a capacity of 10 cores. After the cores are all suspended in place, cast-iron cover plates are lifted into place by the crane. The cores are allowed to remain in the oven about 4 hours. It will be noted that at no point is any mention made of copes. This is because no copes are employed, the molds all are poured *open*. The attention of foundrymen who recommend high heads and risers to promote density is directed to this point.

The molds are assembled for pouring in two shallow pits one of which is shown in Fig. 7. Six baseplates which serve as drags are set up level on short rails on both sides of a pouring platform. Each base is provided with a recess in the center which automatically centers the core. A pin on each side of the base serves to locate the jacket when it is lowered into place. Some of these bases are provided with a shallow recess around the core print. This space is filled with sand which prevents the molten iron from coming into contact with the bare iron face of the base. In other cases the customer specifies that no sand be employed on the bottom end of the mold.

A pocket, the full length of the flask, is provided at one side where the two halves of the flask come together and is employed to contain the long runner through which the iron enters the mold from the bottom. Steel foundry methods are employed in pouring the castings. Bottom pour, 15-ton ladles provided with nozzle and stopper rod are swung by the crane over the round, dry-sand, runner cups on the molds. It will be noted from the examples shown lying on the platform Fig. 7 that each runner cup is provided with two handles and since the cups drain out clean each time they are used one cup will serve to pour from 6 to 12 molds. When using direct metal, the 15-ton ladle is lowered into a pit in the floor and filled from the 25-ton blast furnace ladle mounted on a truck on the railroad track alongside the pit. When using cupola metal, the ladle is placed directly under the spout, where, as previously stated, it can be almost filled at one tap. Bottom-pour ladles are used in connection with direct metal to take care of the *kish* or free carbon that constantly collects on the surface.

Collapsible core barrels of the type designed by Tickner and Leuthner several years ago and first used at the plant of the Lackawanna Steel Co. Buffalo, are used for making the cores. The general features are illustrated in Figs. 8 and 11. The barrel

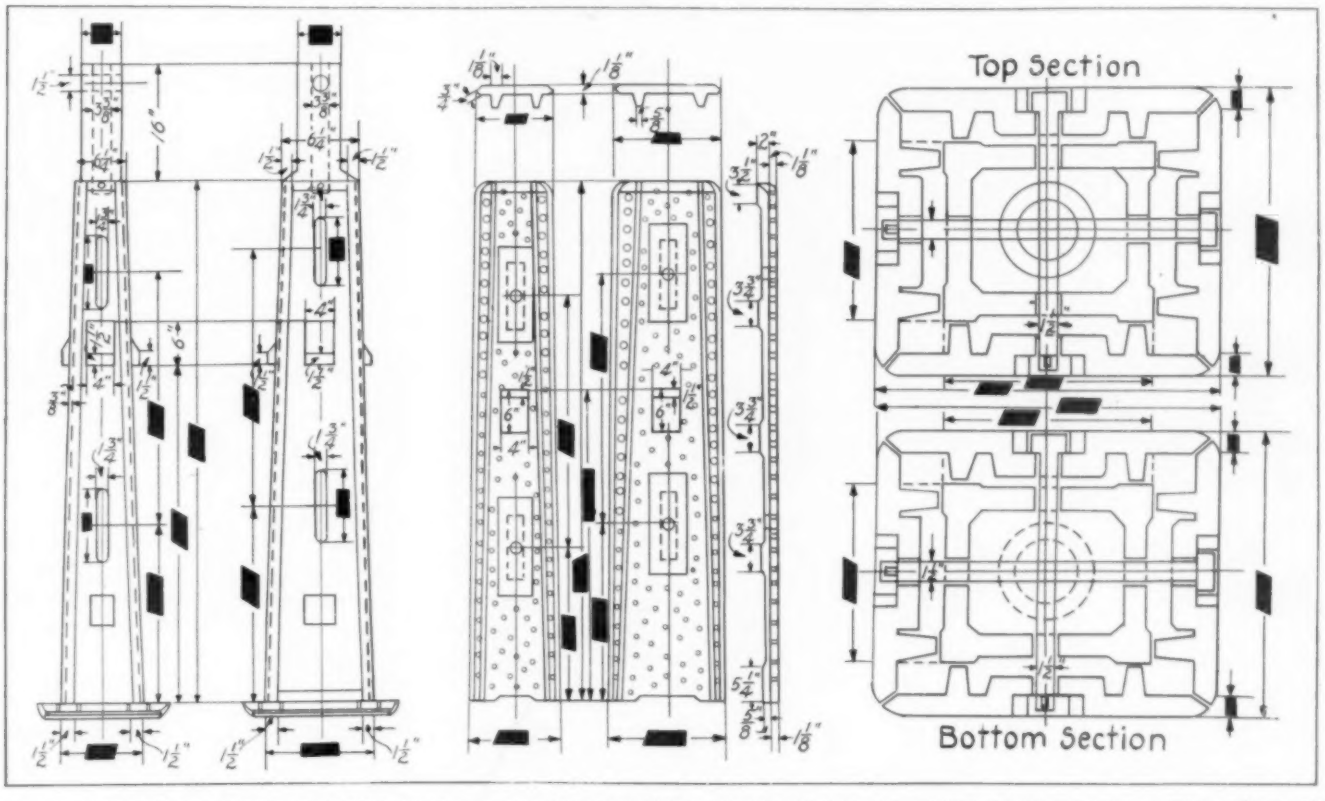



FIG. 8—THE CORE BARREL IS MADE UP OF A CENTER COLUMN SURROUNDED BY FOUR FLAT PLATES HELD BY LONG BOLTS EXTENDING FROM SIDE TO SIDE

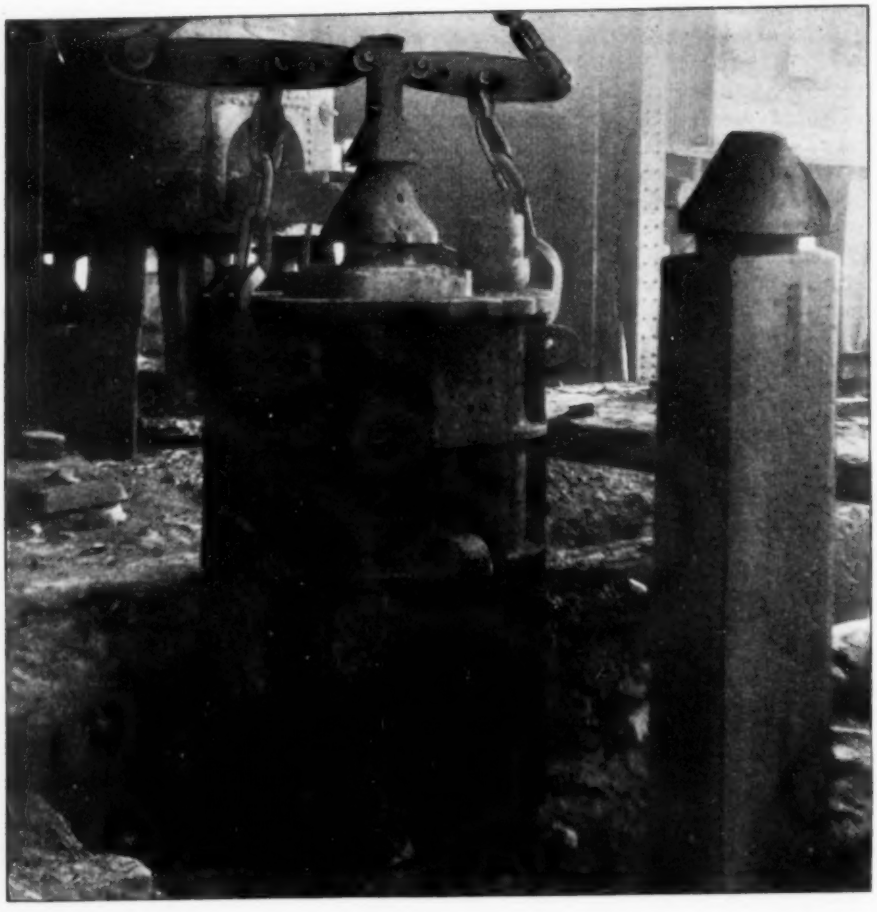


FIG. 9—AFTER THE CASTING IS POURED, THE JACKET AND CASTING ARE STRIPPED BY THE CRANE LEAVING THE CORE BARREL STANDING ON THE BASE

is made up of a center column and four loose plates. The column is provided on the bottom with a square or rectangular base which fits closely into a cavity provided for that purpose in the base or drag of the mold. The four loose plates rest on the shoulder at the bottom and are held in close contact with the column by long bolts extending from side to side through the center of the column. The bolts are slotted close to one end and are tightened by driving a flat key in each slot. The principal advantage of this type of core barrel is that the casting can be stripped by the crane shortly after the molds are poured and without the necessity of taking the barrels to the shake-out floor.

The method of stripping the molds is illustrated in Fig. 9. When the strain comes on the outside chains the plunger in the center pushes down and holds the column of the core barrel in place. The contraction of the casting which comes with the jacket, pulls the loose plates up with it until the bolts extending from side to side engage the top of the long slots in the column. By that time, owing to the taper of the casting, there is a considerable amount of play between the core and the casting and the plates are released and drop back to place as shown in the foreground of Fig. 9. The keys are tapped with a hammer, the core barrel is picked up by the crane lowered into the water tank, clay washed and set in the corebox and rammed up again and the cycle of operations is repeated. In this manner a minimum number of flasks and arbors are sufficient to keep the shop going to capacity.

After the core is released, the crane continues hoisting until the jacket containing the casting is high enough to clear the top of the core arbor. The load is taken in the general direction of the cleaning room and lowered on to the floor where the jacket is stripped from the casting. This is done by lowering the flask on its side, removing the clamps, lifting off one half of the flask, then rolling the casting over and lifting off the second half. The two halves of the flask are reassembled; suitable pins on the joint locate them in their proper relative position, then the flask is picked up by the crane and taken back to the ramming stand.

*Cleaning the Castings*

Comparatively little cleaning is necessary. The sand peels off perfectly both inside and outside. The sand on the inside of course is held by the contraction of the casting, but it is not stuck to the face. A few applications of a long, pointed bar serves to loosen the whole mass which then falls out. A clean, smooth surface is produced on the outside of the ingot mold merely for appearance, but the inside must be perfectly smooth, straight and clean or it will not render satisfactory service when in the steel mill.

Ingot molds are made of all sizes, types and shapes. Some in which the lines prevail straight up and down from top to bottom are known as opentop molds. Others in which one end is contracted to a small round opening are known as bottle-top molds. The bottle-top molds are divided into two general classes, those in which the steel is poured through the small opening and those in which the small end is placed on the stool and the steel is poured in at the large square end. The latter, known as Gathman molds after their originator, are

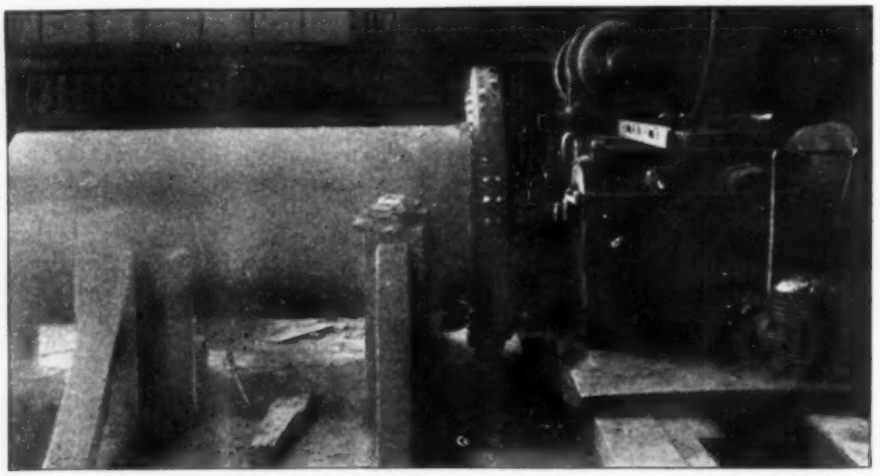


FIG. 10—BOTTLE TOP MOLDS, CAST OPEN-END DOWN AND INTENDED TO BE USED IN THE STEEL MILL CLOSED-END DOWN ARE FACED ACROSS THE SMALL END

provided with a brick hot-top when in use. It is claimed that this method reduces the pipe and the resulting crop end to a minimum. However, the only point that interests the foundrymen is the fact that since the ingot mold is poured bottle-neck up it becomes necessary afterward to machine that end to a true plane so that it will sit level on the stool when in use. The method of performing this operation is shown in the illustration Fig. 10 where an ingot mold casting is mounted on a facing machine made by the Newton Machine Tool Co., Philadelphia.

*Miscellaneous Castings*

An extension on the opposite side of the foundry from the new structure is utilized as a sort of a jobbing foundry. In addition to the stools which form a regular part of the company's product, many other castings are made, including flasks, arbors, plates, etc., used around the plant. This department is spanned by a 10-ton crane made by the Chesapeake Iron Works, Baltimore. The methods pursued in the molding of the different castings does not differ from that in vogue in the ordinary jobbing shop. The stools are made in iron flasks with cope and drag. The half flasks for the ingot molds are bedded in the floor, concave side up and the hanging body of sand is supported by a cast iron arbor suspended from the iron cope. The ingot mold foundry is served by three 20-ton cranes, each with a 5-ton auxiliary hoist, and one 15-ton crane.

The company maintains a well-equipped pattern shop in which patterns are made for ingot molds to suit any or all requirements. They are made according to the design and under the instruction of George A. Evans, general superintendent, who has specialized for many years in the manufacture of this class of castings. Other buildings about the plant include a blacksmith shop, a machine shop and a warehouse for the storage of supplies, brick, clay, blacking, etc. The main office of the company is located in Wheeling, West Virginia.

## Book Review

*The Electric Furnace*, by Frank J Moffet; cloth; 118 pages, 4 x 6¼ inches; published by Sir Isaac Pitman & Sons, Ltd., and for sale by THE FOUNDRY; price $0.85, postpaid.

Descriptions of practically all types of electric furnaces are given in this book which is of convenient pocket size. The fundamental technology of electric heating is treated from the electrical and metallurgical viewpoints. Some of the principal subjects discussed are electrical units and power, conversion of electrical energy into heat, hydraulic analogy, and alternating two and three phase currents. A chapter is devoted to the history of the electric furnace, the work of Pepys, Siemens, Moissan and others being reviewed. The characteristics of arc and induction furnaces for steel and iron, the fixation of nitrogen, and the materials used in furnace construction are discussed. The qualities required in electric furnace linings, including ability to withstand high temperatures, resist chemical action, retain mechanical strength and density, and maintain shape in spite of alterations in temperature are emphasized in an interesting chapter. The text is accompanied by 33 illustrations and five tables containing technical data. A short bibliography also is presented.

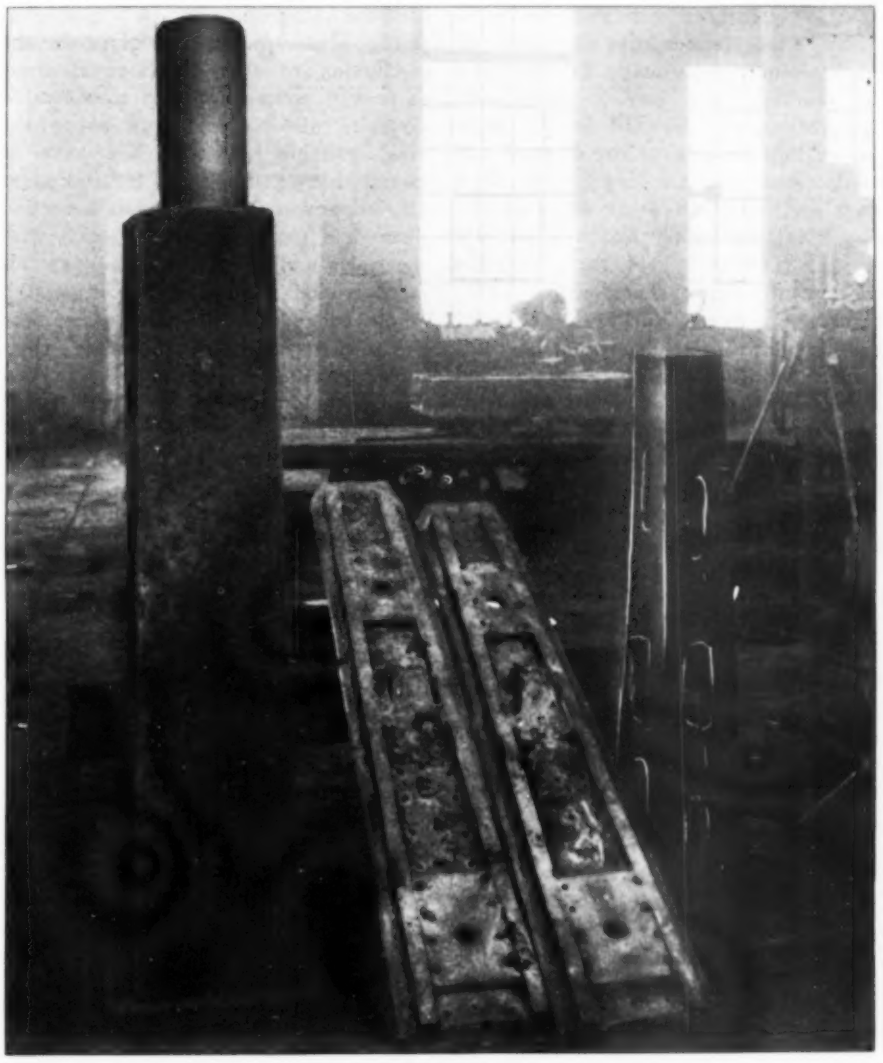


FIG. 11—THE COMPANY MAINTAINS ITS OWN MACHINE SHOP WHERE FLASKS AND CORE ARBORS ARE FITTED AND ASSEMBLED BESIDES EXECUTING ANY NECESSARY REPAIRS

The Crown Foundry Co., Peoria, Ill., recently organized by H. R. Hire and others, is constructing a gray iron foundry which will be completed about April 15.

## Appointed Sales Agent

L. J. Buck has been appointed sales representative in the United States for the British America Nickel Corp., Ltd., Ottawa, Can. Mr. Buck who formerly was connected with the National Carbon Co., has established offices at 342 Madison Ave., New York. The British America Nickel Corp. is a Canadian firm operating mines in the Sudbury district. Its refinery is located at Deschenes near Ottawa.

## Addresses Association of Purchasing Agents

O. P. Hood, chief mechanical engineer, bureau of mines, addressed the February meeting of the Purchasing Agents' Association of New York. The speaker told of the efforts of the bureau to bring about standard classification of coal grades backed by government guarantee.

# British Motor Castings Methods—VI

## Pistons Molded Four on a Gate Either with the Open End Up or Down—Methods Described for Molding Water-Inlet, Front-Cover and Oil-Pan Castings

BY BEN SHAW AND JAMES EDGAR

PRODUCTION of suitable castings for pistons is frequently a source of worry to the foundryman because of cracks which occasionally develop after the castings have cooled. Sometimes this weakness is detected directly after the casting is cleaned, or it may not be detected until the casting has been machined, while in other cases cracks may develop after the piston is actually in use. The design of these castings is frequently responsible for this weakness, the varying thickness of metal and the drawing tendency of the comparatively heavy bosses create internal stresses which are difficult to avoid. Also the character and quality of the metal has a considerable influence on the quality of the casting. Various alloys have been tried for pistons, those of aluminum having been successfully employed in special cases. The pistons made from aluminum alloys are subjected to heat treatment to dispose of internal strains, either by boiling in oil at a temperature of about 300 degrees Fahr., or in an annealing furnace. The production of castings from these alloys is comparatively limited as satisfactory commercial results are obtained by using a suitable grade of cast iron. Sometimes the pistons are cast long enough to provide the rings, but it is much better practice to make separate castings from which to cut the rings. Incidentally, it is preferable to use a mixture of slightly different composition to that used for the pistons.

The actual molding involved in the production of these castings is comparatively simple and yet considerable diversity of opinion exists as to the most suitable methods. We have illustrated two methods for purposes of comparison. Fig. 1 shows a section through a mold arranged to cast with the open end of the piston down. It is contended that when this method is employed risers can be used which feed the thicker parts of the castings, then, owing to the thinner part being cast down, the metal enters readily and its temperature need not be high.

### *Four Patterns on a Gate*

When this method is adopted a number of patterns are usually attached to a plate, as shown in Fig. 2. Mounting four patterns is the customary practice. One down gate is used with a runner to each piston. One of the disadvantages of this method is the difficulty in setting the core, as it must be lowered below the joint surface of the mold and a perfect fit in the print impression is essential, otherwise the core will float when the metal is poured. A small templet should be used to make sure that the top thickness is correct.

More frequently pistons are cast the other way up. To do this the patterns are mounted as in the method first described but the down gate is cut as shown by the dotted lines in Fig. 1. With this method a head can be cast on the open end giving greater pressure when casting, which makes the metal about the closed end closer grained. Furthermore it gives the advantage of bottom pouring. In this method the core is suspended in the cope, being wired to maintain its position.

Another method is sometimes employed for supporting the core, which dispenses with the need for wiring. Such a method is illustrated in Fig. 3. In this instance the drag merely takes the bottom impression of the gate, the cope taking all the mold, and the core print at the top forming the cover. When this method is adopted it is customary to make the height of the print such that the total height of the patterns coincides with the height of the flask to be used. The pattern, in this case also, is usually arranged to cast four at a time. In each case the molds must necessarily be clamped before pouring, and a skimming gate at the top is desirable. In the latter it is necessary to weight the cores. Hotter metal is required when the open end is cast up but it need not be poured so quickly.

Of the detail castings required in aluminum the bottom part of the crankcase, or oil pan, gives as much

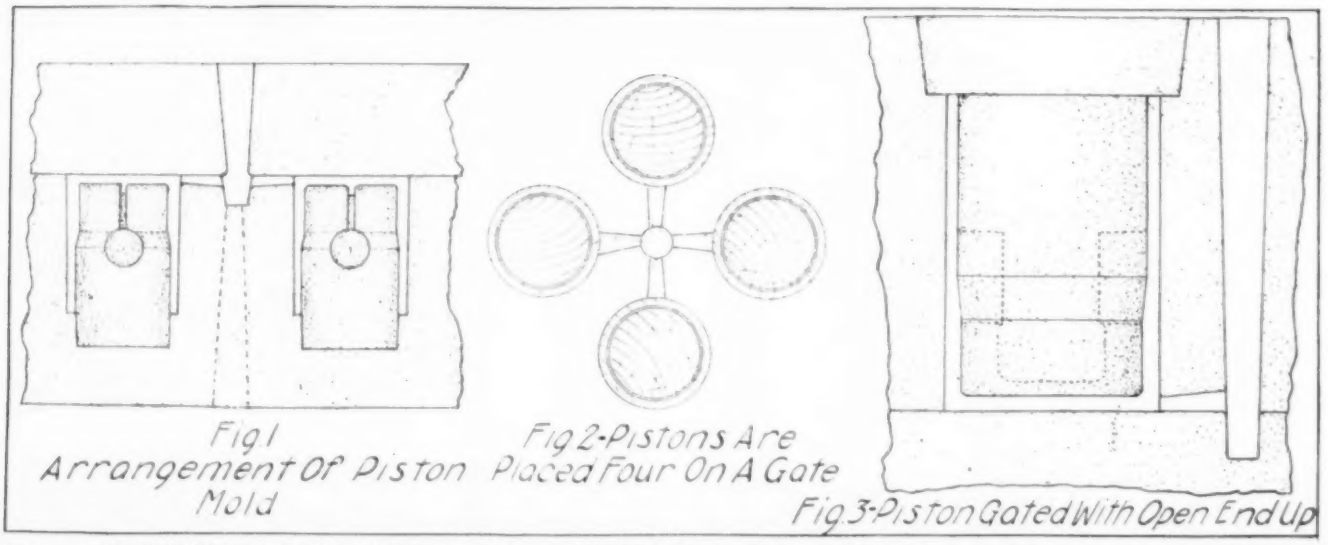



FIG. 1—ARRANGEMENT OF PISTON MOLD FIG. 2—PISTONS ARE PLACED FOUR ON A GATE FIG. 3—PISTON GATED WITH OPEN END UP

trouble as any. In some foundries this is run by the use of plumb gates, much in the same way as cast-iron bathtubs. However, it is more advantageous to adopt bottom pouring so that the flow of metal is disturbed as little as possible, thus reducing the chances of aluminum oxide collecting in the metal and being trapped. Risers are of course essential to feed the heavy sections which come in the top of the mold, but the bosses carried in the main core may have denseners to make the cooling more rapid and make convenience. An ordinary solid flask with straight bars will suffice, such as is shown in Fig. 4. When one machine is operated for both cope and drag it is advisable to prepare a number of drags so that the cores can be set ready to receive the copes as they are finished. The small boss shown on the outside of the pattern will need a denseners.

The core can be produced most readily on a jolt-ram machine. It is important that the core is of such a composition that it quickly disinte-

above the cope, as shown in Fig. 7, to increase the pressure of metal in the mold. The prepared basins for pouring aluminum should be deep rather than shallow, and a head of metal should be maintained until the risers are full.

Water inlet castings are made in several types. The more common type, that which has a full connection over the cylinders, is considered in this article. It is necessary to make one reference to those which carry a number of separate branches. Foun-

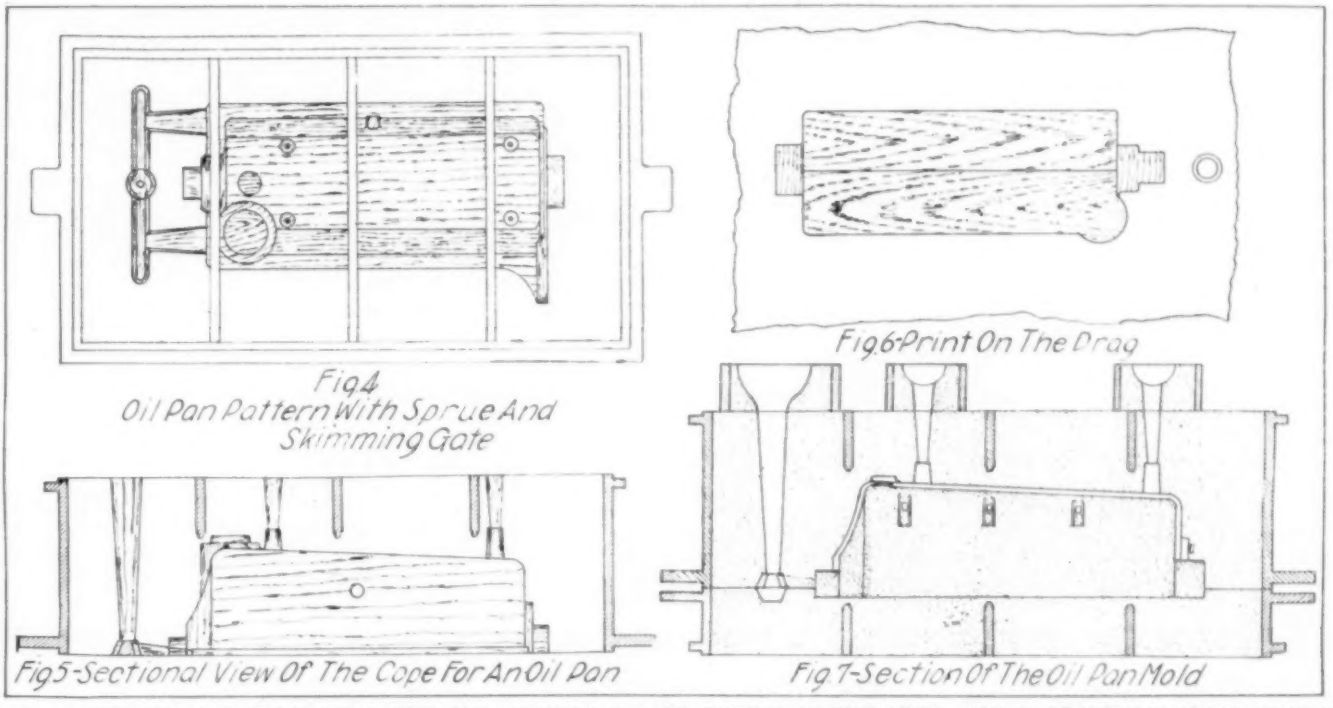


Fig 4
Oil Pan Pattern With Sprue And Skimming Gate
Fig 6-Print On The Drag
Fig 5-Sectional View Of The Cope For An Oil Pan
Fig 7-Section Of The Oil Pan Mold

FIG. 4—OIL PAN PATTERN WITH SPRUE AND SKIMMING GATE SHOWN AT THE LEFT FIG. 5—SECTIONAL VIEW OF THE COPE FOR AN OIL PAN FIG. 6—PRINT ON THE DRAG FIG. 7—SECTION OF THE OIL PAN MOLD

them cool at approximately the same rate as the remainder of the casting.

These castings are more accurately produced and have a better finish when a suitable molding machine is used. With a jolt-ram machine sand is more evenly and regularly packed an important consideration in molds to receive aluminum. With a pattern-drawing arrangement the accurate withdrawal of the pattern reduces the need for tooling. The drag is arranged to carry only the print impression and part of the skimming gate. The pattern should be secured to a plate, with suitable sprues attached, and equipped with a skimming gate, as indicated in Fig. 4. It is convenient to use dowels for locating the gate and risers and for keeping them in position while the sand is being introduced into the flask. The print and the other section of the skimmer may be attached to the opposite side of the same plate, making a form of match plate. However, it is preferable to use a separate plate for

grates after the metal has been poured, otherwise the casting will crack or become distorted. An oil bond is desirable as it quickly carbonizes and does not greatly reduce the pore space. A sectional view of the cope showing the relative position of the pattern with regard to the flask is illustrated in Fig. 5. In some cases a thin print is preferred for the core which forms the hole in filter branch. However, the print is unnecessary as this core is more satisfactorily carried with the main core and it should be set so that the cope barely touches it when the mold is closed. The shape of the print carried on the plate for the drag is shown in Fig. 6, and a section of the finished mold is shown in Fig. 7.

It may be noted that the skimming end of the gate is carried partly in the drag, and that the gate is comparatively large. This is necessary to give a good supply of live metal. The risers and pouring basin are carried

dries frequently receive patterns for this type of casting with the prints from these branches following the diameter of the holes required, and as a rule no effort is made to lengthen them. When this occurs, the molder must necessarily chaplet the core, as it is unbalanced. Chaplets should be excluded from this form of casting unless it is impossible to dispense with them. When individual branches are carried a block print should be used so that the core is well balanced between the inlet branch print and the block print. When this method is adopted it relieves the foundry of much trouble and a better casting is produced. The core provides the face for the major part of the joint flange when a block print is used, and it makes a sounder job.

This inlet casting also being composed of aluminum involves the same precautions as already have been mentioned. It differs slightly from the preceding castings in the method of

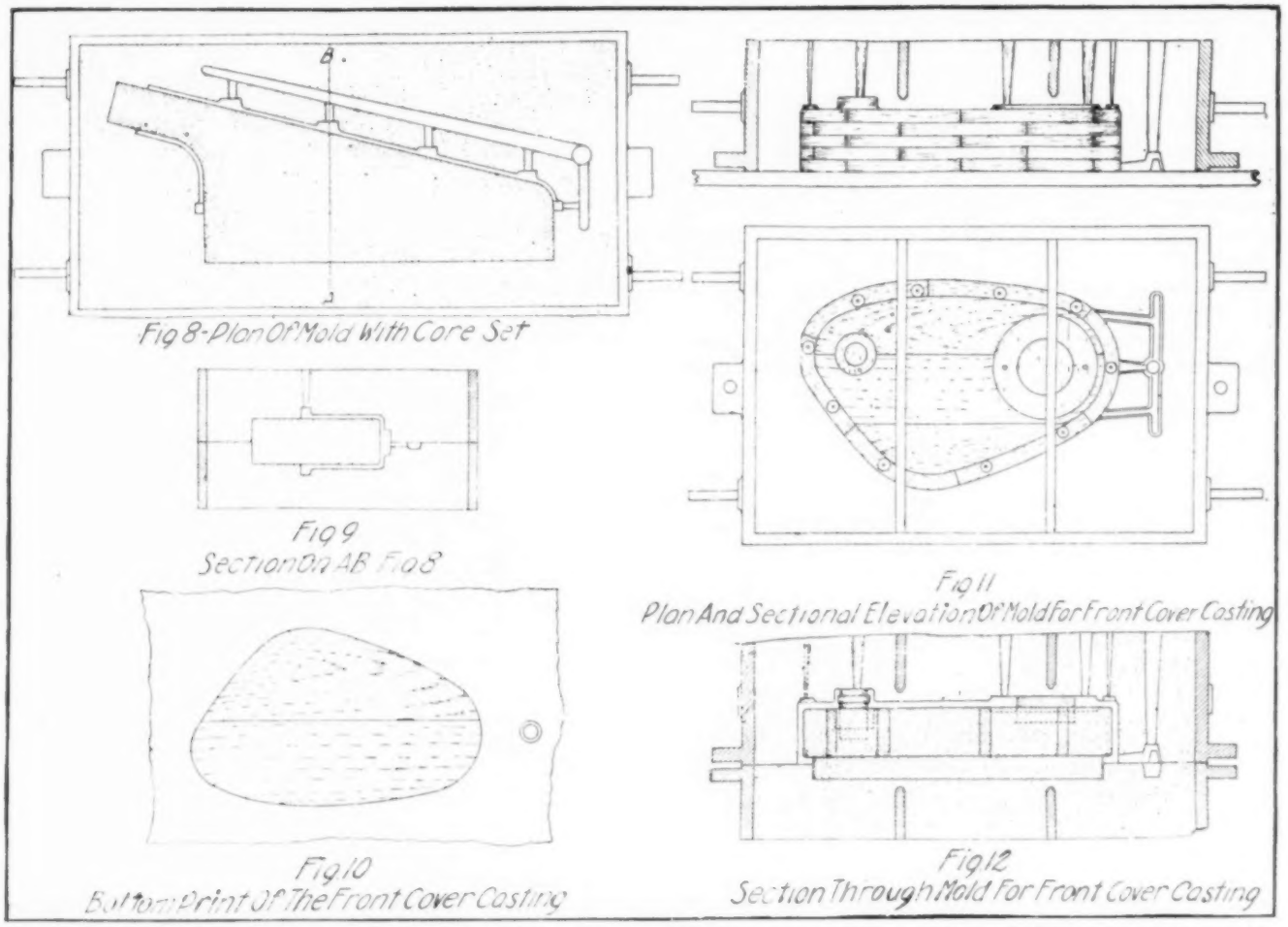


Fig 8-Plan Of Mold With Core Set
Fig 9
Section On AB Fig 8
Fig 10
Bottom Print Of The Front Cover Casting
Fig 11
Plan And Sectional Elevation Of Mold For Front Cover Casting
Fig 12
Section Through Mold For Front Cover Casting

FIG. 8—PLAN OF MOLD FOR WATER INLET CASTING FIG. 9—SECTION ON *A B*, FIG. 8 FIG. 10—BOTTOM PRINT OF FRONT COVER CASTING FIG. 11—PLAN AND SECTIONAL ELEVATION SHOWING ARRANGEMENT FOR MOLDING THE FRONT COVER CASTING FIG. 12—SECTION THROUGH MOLD FOR FRONT COVER CASTING

running. In this instance it is more convenient to supply the metal by way of the joint, particularly because of the bosses which are cast on. These bosses form thicker metal and are likely to be spongy unless they are fed. This can be provided for by running the metal as indicated in Fig. 8. Then besides supplying metal, the sprues also act as feeders to the heavier sections. The down gate should be large enough to maintain a continuous flow of metal through the runners. The pattern for this casting would be parted longitudinally along the central plane, and it can be conveniently located on a plate for the purpose of molding on a machine.

When suitable flasks are available it is quicker and more convenient to set both halves of the pattern on one side of a plate in such a way that two impressions taken from it will coincide when brought together. Only one main runner need then be used and it would save changing the plate for making the copes. A couple of risers from the top of the flange will suffice. It is advantageous to make provision for locating the risers and the gate stick. A section through the completed mold is shown in Fig. 9. It should be noted that the cope come directly in contact with the core at the ends during the time of lowering; hence it is advisable to have

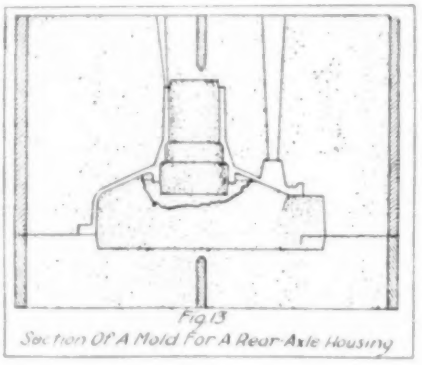



FIG. 13—SECTION OF A MOLD FOR A REAR-AXLE HOUSING

plenty of taper on the print. However, the core need not necessarily be made to carry the same taper as long as it can be set easily and accurately.

The front cover is a smaller aluminum casting and is molded so that the open end is cast down, and the metal is supplied at the bottom where the section is a little heavier owing to the presence of an internal flange. It is necessary to have a good head of metal when casting in this way. The gates should be sufficiently large to supply the metal quickly. They are better made a little less in thickness than the internal flange. The bosses about the inside of this casting are comparatively small, being ½ inch in diameter, therefore, it is not essential that risers be used. However, a needle vent should be brought off each boss, and they will suffice, providing the metal is the right temperature.

The method of preparing the pattern for machine molding is somewhat similar to that used for the oil pan. The large bottom print is located on a plate as is also part of the skimmer, as shown in Fig 10. The pattern is secured to the other side of the same plate, or another plate may be used according to the practice of the foundry doing the work. Accuracy in setting these on plates is of vital importance and many methods are used to secure this end. A good plan is to have the standard plate of one size drilled in a number of places convenient for locating patterns from

the one jig. These holes should of course have the same relation with the guide pins for each plate. After the print has been secured to the plate, about three holes through the plate, which are covered by the print, should be chosen and a continuation of the holes should be bored through the print. Then return the print to the pattern and continue the holes into the pattern. When the print is removed, insert guide pins or dowels into the pattern. Its position then easily can be located on another plate. Fig. 11 shows the type of flask suitable for a job of this kind, and also the position of the pattern relative to it. The small pin holes shown are an advantage for locating the gate stick and risers.

Three risers will suffice for this job with the aid of needle vents. Prints need not be carried on the top of the pattern. The proper place for them is the corebox. Top prints, unless considerable care is exercised, are liable to cause crushing when the mold is being closed. A number of impressions should be taken of the print first so that the cores can be set, as explained when dealing with the previous crankcase casting. After the small cores have been located it is profitable to test the heights above the main core before the cope is lowered. Fig. 12 illustrates a section of the completed mold. Provided with a first class pattern and corebox, tooling is unnecessary and only adds to the expense of production.

The rear-axle housings vary considerably in design and incidentally in the metal of which they are composed. Sometimes aluminum is used; for ordinary commercial work cast iron is frenquently employed, whereas in exceptional cases these castings are made of steel. Generally the molds are prepared to be cast with the flange down. The production of the molds on a machine closely resembles the procedure employed in connection with the front cover previously referred to. Bottom pouring is preferred, and risers are brought off from the highest points, as illustrated in Fig. 13. The core in this instance is somewhat awkward. It conveniently can be made in one when it is possible to dispense with the top print. However, many molders prefer to have this type of core in two pieces, and owing to its length in comparison to the diameter, a top print is necessary to secure accuracy. When a top print cannot well be dispensed with, it should not exceed ½ inch in thickness and should be well tapered. Small denseners against the outside of the lugs on the bottom flange are desirable when these castings are made of aluminum. In connection with this metal particularly, it is profitable to ease the castings shortly after the metal has been poured. It is good practice to shake them out before the metal has cooled down to the normal temperature. However, care must be exercised in doing so as the metal is comparatively weak and liable to be broken or misshapen if handled roughly. In releasing the castings as soon as practicable, they are considerably relieved from internal stresses to which they would otherwise be subjected.

# Correcting Flaws in Metals and Mixes

**Problems of the Gray-Iron, Malleable and Steel Foundry Discussed**
**By H. E. Diller**

## Ways of Correcting Leaky Engine Cylinders

*Question*—Is the following composition correct for iron for gas engine cylinders: Silicon, 1.90 to 2.10 per cent; sulphur, 0.350 per cent; phosphorus 0.60 to 0.70 per cent; manganese 0.40 to 0.55 per cent? What pressure is used for testing cylinders for leaks, and how can leaks in cylinders be stopped?

*Answer*—The composition which you give for gas engine cylinders is a little low in manganese. We would prefer manganese to run from 0.55 to 0.90 per cent instead of between 0.40 to 0.55 per cent as given by you. Sulphur should not run over 0.120 per cent and phosphorus should be about 0.2 per cent and not above 0.3 per cent.

Cylinders are usually tested under 50 pounds water pressure. Some shops test the cylinders as soon as they are rough machined and test them again after being finished machined. The best practice is then to throw out any cylinders which leak in the bore. However, some foundries rust the cylinders by allowing them to weather for a few months or by wetting them with a sal ammoniac solution. By the use of sal ammoniac, the holes rust shut much quicker than if no artificial means are used. Holes in the outside of the water jacket are stopped by drilling through the casting at the place of the leak, tapping a thread in the hole and closing with a threaded plug of cast iron.

## Burned Iron Sets Quickly

*Question*—I am having a heavy loss of castings. The iron comes from the cupola white hot but seems dead and does not run well. The bed in the cupola is 22 inches high and the metal charges weigh 400 pounds with 80 pounds of coke between each charge.

*Answer*—Your trouble is due to oxidized iron. This comes from having too low a bed in the cupola. The coke in the bed should be 25 to 30 inches above the tuyeres. If there is not enough coke in the bed the air from the tuyeres will strike the iron and burn it instead of burning coke. This will make a hot metal as it comes from the cupola but the metal will soon become dull.

## Iron Comes Too Soft

*Question*—Our malleable iron comes too soft from the melting furnace, frequently showing some carbon spots. Our mixture for a 5-ton heat consists of 4500 pounds of pig iron, 2000 pounds annealed scrap and 3500 pounds of our own sprue. The pig iron charge is made of 1000 pounds with 2.00 per cent silicon; 1500 pounds with 1.86 per cent silicon; and 2000 pounds with 0.85 per cent silicon. We tried adding 800 pounds of steel to this but even then got mottled iron.

*Answer*—Two things would cause your iron to be soft and show a mottled structure. One of these is too high silicon and the other is too high a manganese content. Manganese should not be over 0.3 per cent and silicon not over 1.0 per cent. If your castings are moderately heavy, even less silicon should be in the iron. Although we can not determine the amount of silicon which is in your iron, as we do not know the composition of your scrap and sprue or the amount burned out during your melting operations, we would judge there is more than 1 per cent

of silicon in the iron as it comes from the furnace. Not knowing the composition of your scrap iron we could only recommend that you use more of the iron with 0.85 per cent silicon. You should not use any more annealed scrap nor more than 5 per cent steel scrap in the mixture. Analyses should be made.

## Metal for a Steam Chest

*Question*—We would like to know a good mixture of iron for making steam chests for laundry mangles.

*Answer*—For such castings we would recommend an iron with silicon from 1.75 to 2.00 per cent; sulphur less than 0.10 per cent; phosphorus, 0.20 to 0.30 per cent, and manganese, 0.50 to 0.80 per cent. Thirty to 50 per cent of cast-iron scrap of known composition should be used. As high as 12 per cent steel scrap may be added to the mixture but this is not necessary. The remainder of the mixture should be pig iron of such composition as to give an iron of the analysis mentioned. This metal should be poured hot and strainer cores should be used to prevent dirt entering the mold.

## Remedy for Chill Cracks

*Question*—We have considerable trouble with and would like to know how to avoid chill cracks in mine car wheels.

*Answer*—Chill cracks are due to a number of different causes, and manufacturers try many expedients to prevent them. The general custom in manufacturing mine-car wheels and other smaller wheels is to keep the sulphur below 0.1 per cent and to use a large percentage of charcoal iron in the mixture. Getting the wheels into the soaking pit quickly after they are poured also will assist in preventing cracks. Sometimes the pig iron that is used has been incorrectly smelted and has been oxidized in the process. This would tend to increase the chill cracks and the only remedy for cracks due to this cause would be to secure a different iron.

## Iron Wrinkles on Chill

*Question*—We have trouble with a chilled casting we are making. We use good chills and patterns and take particular pains in greasing the chills, but the face of the casting which is formed against the chill comes out wrinkled as though the iron had been poured cold.

*Answer*—The trouble is from no other cause than low temperature. Either the iron is too cold as it is poured, or it is poured too slowly and cools too quickly as it goes against the chill. If you are pouring your iron at a high temperature you should increase the size of the gate leading into the mold.

## Melts in a Small Cupola

*Question*: We have had to line our cupola to 24 inches in diameter, and would like some advice as how to operate it.

*Answer*: The bed of coke should be 26 inches above the tuyeres when the charging commences. Each charge should contain 800 pounds of pig iron scrap and 100 pounds or less of coke according to how you find the iron melts. It would also be of advantage to break the pigs in half and to use comparatively light scrap. The blast pressure should be 12 to 14 ounces.

## Semisteel for 30-inch Wheel Castings

*Question*—We desire to make some wheel castings 30 inches in diameter and weighing about 170 pounds. The material called for is semisteel with a tensile strength between 30,000 and 35,000 pounds and soft enough to machine easily. We should like to know the proper charge to meet these specifications and also if the semisteel could be run off early in the daily heat. The pig iron we have on hand shows the following analysis:

| | Per cent |
|---|---|
| Silicon | 2.6 |
| Sulphur | 0.02 |
| Phosphorus | 0.44 |
| Manganese | 0.55 |

*Answer*—You should use a mixture of 30 to 40 per cent good machinery scrap, 15 per cent steel scrap and the remainder pig iron. The castings should have a composition of:

| | Per cent |
|---|---|
| Silicon | 1.6 to 1.8 |
| Sulphur below | 0.12 |
| Phosphorus below | 0.4 |
| Manganese | 0.6 to 0.9 |

The semisteel can be charged either at the first or the last of the heat. The latter is preferable if you have some molds into which the first of the semisteel may be poured, thus making certain that nothing but semisteel is available for pouring the wheels.

## Acid Resisting Iron

*Question*—Please tell us how acid resisting iron castings are made.

*Answer*—Acid resisting castings are made of high silicon iron, containing from 13 to 15 per cent silicon. The phosphorus usually is kept down below 0.20 per cent while the carbon varies from 0.20 to 1.30 per cent in castings made by different manufacturers. Manganese and sulphur also are quite variable, the manganese ranging as high as 1.50 per cent in some irons, and the sulphur as high as 0.150 per cent. Such irons can be made in the air furnace, the open-hearth or the electric furnace.

## Light Machinery Castings

*Question*—Kindly tell us which grade of pig iron we could use to best advantage to make light machinery gray-iron castings, so that they will not be too hard.

*Answer*—The grade of pig iron you get would be dependent somewhat upon the amount of scrap you used. You should get some No. 1 and No. 2 pig iron and specify in your order that the pig iron shall contain not more than 0.05 per cent sulphur, between 0.4 and 0.6 per cent phosphorus, and between 0.5 and 0.8 per cent manganese. Silicon in the No. 1 should range between 2.5 and 3 per cent and in the No. 2 between 2.0 and 2.5 per cent. You could then make your mixture using No. 1 pig and 35 to 60 per cent of a good grade of uniform scrap. Then start to add a small percentage of No. 2 pig iron and gradually increase the amount of this which you use until you find a tendency to hardness.

## Largest Cylinder Cast

*Question*—What was the largest and heaviest cylinder casting ever made in this country.

*Answer*—Cylinders for marine work are the largest type built. A cylinder furnished to the New York navy yard weighed approximately 50,000 pounds as finished. It had maximum overall dimensions 11 feet, 2½ inches long, 12 feet, 1 inch wide and 9 feet, 1⅛ inches high.

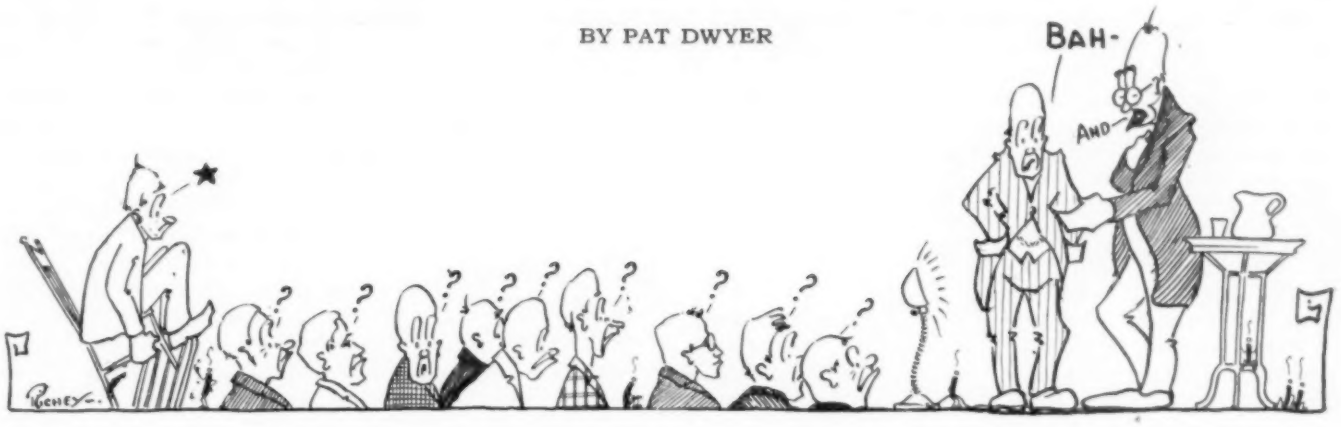
## Liners for Ball Mills

*Question*—What should be the composition of iron castings for the liners for ball mills?

*Answer*—Ball mill liners are frequently made in the air furnace of an iron of a composition similar to malleable iron, but they are not annealed. The silicon should be kept between 0.5 and 1.0 per cent, depending upon the thickness of the casting, higher silicon being used for castings of the thinner sections. If cupola iron is used, the sulphur should be kept below 0.12 per cent; phosphorus below 0.5 per cent, and manganese between 0.4 and 0.7 per cent. If air furnace iron is used, the sulphur should run below 0.08 per cent; phosphorus, as in malleable iron, should be kept below 0.02 per cent, and manganese below 0.3 per cent.

# Bill On Pattern Mounting Methods—IV

BY PAT DWYER




MANY years ago at a time of life when I found the days altogether too short for my many activities, when I had the hours devoted to sleeping, eating and working pared down to the irreducible minimum and the hours devoted to enjoyment extended to the full elastic limit, if one is justified in employing this sedate, serious and scientific term in such a frivolous connection, I spent several hours one night out of every week exercising to the full all my rights and privileges as a duly qualified and elected member of a debating club. We did not discuss any revolutionary or abstruse problems, but confined our efforts to the regular old stand bys, hardy perennials you might say, favored by standard debaters the world over.

This form of indoor sport languished and died each year when the first warm zephyrs of spring came stealing over the great outdoors, when the wild geese went winging north and the pussy willows began to show a tinge of green along the brooks. However, it always sprang up again with the first nippy nights in the fall, when the same *V*-shaped squadrons that drifted northward a few months before, passed high overhead on their way south to the delta of the Mississippi and the feeding grounds that extend along the shore of the Gulf of Mexico from Florida to old Sonora. You know those kind of nights where the rush of not air is grateful and comforting as you open the door and the smell of blistering paint on the old round, potbellied stove feels good in the nostrils. On nights like those we spilled floods of oratory deciding whether the sailor endured more hardship in the pursuit of his calling than the soldier and whether country life was preferable to life in the city. At that time we lived in a little town of about 5000 and naturally felt competent to discuss the advantages enjoyed by those fortunate enough to live in those places designated in the census returns as large centers of population. Other subjects receiving a fair measure of our attention included the problem, whether the reader or the traveler had the better chance of acquiring an education; whether the mariner's compass or the printing press had conferred the greater benefit on humanity; whether a shoemaker was more necessary to a community than a tailor and, finally, whether a sheep was of more direct value to a farmer than a grindstone.

At the present time I cannot recall that we ever definitely settled any of these momentous questions, although heaven knows we upheld our respective contentions with all the vigor and enthusiasm and, if the truth must be told, with all the bull-headed innocence and ignorance of youth. The fact that we were as ready and willing to talk on one side of the argument as the other may have had something to do with keeping the various questions alive.

Shortly after I finished serving my time in the foundry I flew away from the old home town under just as irresistible an impulse as that which drives the wild geese north and south with the changing seasons and naturally I lost touch with the old debating club. I never have joined one since and practically had forgotten that such things existed until I received a letter a few days ago from a young man who said that he expected to uphold the negative side of a resolution to the effect that the agricultural industry was of greater importance than the iron industry. He lived in an agricultural community and would have felt more at home in supporting the resolution, but to develop any interest in the debate it was essential that some one should speak on the negative side and he had been selected for the purpose. He might have refused, but you know how it is.

He admitted that he did not know whether iron was quarried out of the ground like stone and then cut into the various shapes in which we see it; or, if it first was softened in some manner and pressed into shape. He stated that he would appreciate information on that point and in fact on any point on which I might care to enlighten him. If I should look upon the idea favorably he would suggest that I divide the topic into three parts, historical; development; and manufacturing processes. He thought the subject could be covered in about 3000 words and if I kindly would mail him, say, ten typewritten pages, double spaced for convenience in reading, he figured he would be able to knock 'em all dead on the night of the debate and in the meantime he begged to remain truly yours Silas Hoopendyke, Poplar Hollow, Iowa. My first impression was that the young man might be lacking in knowledge connected with the iron industry, although I only

A BIRD ON THE WING SOON GETS OUT OF THE BUSHES

had his word for it; but he certainly was not lacking in self assurance. In addition, he seemed to have a fair working knowledge of the game usually associated in the mind of the public with those who make the greater part, or all of their living, by their wits,—passing the buck. First impressions are not reliable always and to give my unknown correspondent the benefit of any reasonable doubt I consulted Bill before taking any action. I reflected that one day's delay would not detract from the value of the manuscript—if I decided to send it; while if I decided not to forward the necessary information, the elapsed time would prepare the young man in a certain measure and he would not feel so disappointed. I was greatly relieved to find that Bill's views coincided with mine. "I bet you" said Bill "That bird never did a hands turn in his life if he could get some person to do it for him. I have worked for men like him, short engagements of course, but long enough to size them up. Anything pulled off in the shop worthy of mention is entirely due to their wise and skilful leadership. They bask right in the spot light and boldly claim any bouquets that may be floating around. When anything goes wrong they never by any chance are responsible. A bone-head play on the part of some other person in direct violation of instructions always causes all the trouble. So far as I can see there is no good and sufficient reason why your friend cannot dig up the information from an encyclopedia. In these modern days there is not a hamlet in the land big enough to support a debating team, but can show an encyclopedia of some kind in one or more of the houses. The towns and large cities without exception are provided with public libraries where a man can find information on practically any and every conceivable subject.

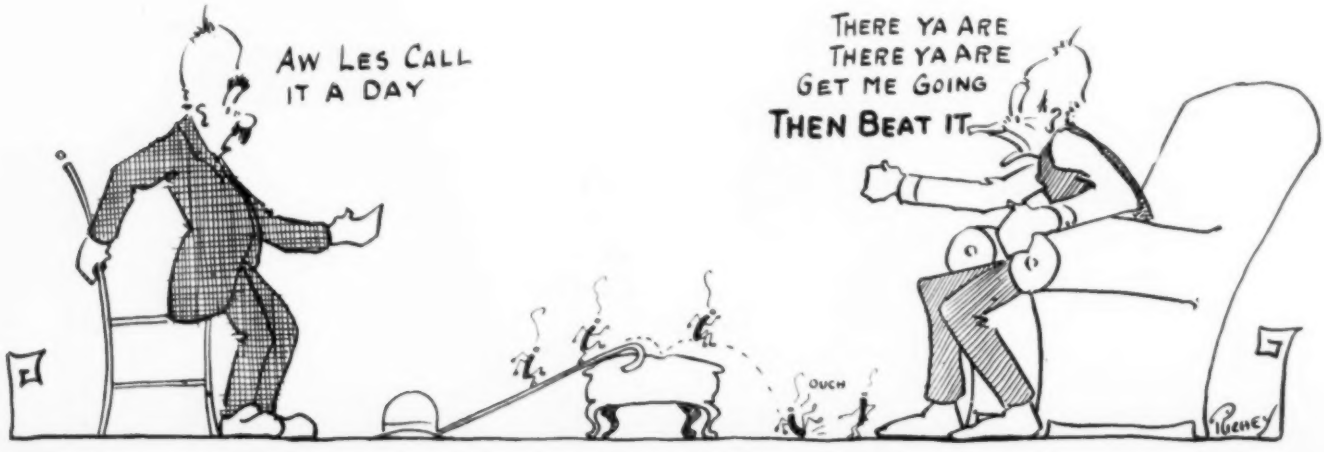
"The self satisfaction of Jerry Hooperup, or whatever his name is, plainly is shown in the closing part of his letter where he *suggests* that you do the work for him in a certain manner. Not content with gyping the gang at the other end of the line he wants to make you believe that he is a wonderfully clever lad who knows exactly what he wants and how he wants it. Write him to the effect that you fully appreciate the implied compliment, but that really it is his debate and not yours and that a natural shyness and reserve prevents you from presenting your views even by proxy before strangers. Tell him to look in that volume of the encyclopedia marked GRE-ITA and he will learn enough about iron to carry him through several debates. Personally I think you ought to treat him rough. You may handle him with gloves if you like, but if I had my way I should handle these birds who pinch other men's ideas and pass them off as their own, with a pair of tongs—hot tongs."

HE HELD THE LONG DISTANCE THROWING CHAMPIONSHIP

"All right" I said "All right, now that you have that off your mind I should be interested in hearing something further on the subject of pattern mounting. The night is young and you should be able to cover quite a bit of ground before I retire to my den to write."

"Well" said Bill "I'll tell you. In addition to the points already touched upon, the subject may be considered under three general heads. (1) The use of plaster and other compounds. (2) Metal matchplates in which the upper and lower parts of the pattern form an integral part of the plate. (3) Plates on which the pattern or patterns are arranged in such a manner that cope and drag of mold may be rammed alternately on the same face. So far as I know none of these pattern-making processes is patented and material can be secured from any of the foundry equipment supply houses for doing the work. The formula for the materials, with the exception of plaster which can be purchased in the open market anywhere, are protected by patent; but there is no limit to the method of application. Matchplates and similar devices of a like character are designed primarily to expedite production and enable men with little or no training to produce good castings. The preparation of these mechanical aids, while in some cases not extremely difficult, still as a general rule should only be intrusted to skilled men familiar with this class of work. The most important point to be borne in mind is that suitable frames should be employed, provided with accurately fitting guides to insure that the two parts of the mold register perfectly when brought together. While some foundries make their own frames, the greater number find it more convenient to secure them ready made through regular supply houses.

"The material for forming pattern mounts is furnished either as a substance which may be rammed and finished like sand and which becomes exceedingly hard when allowed to stand for some time; or as a powder which can be




IN REFINED FOUNDRY CIRCLES NO PERSON THINKS OF QUITTING UNTIL THE BOTTOM DROPS—IT IS NOT DONE

mixed with water to the consistency of cream and poured into any desired shape. Under certain conditions the latter method is more flexible, inasmuch as it can be employed to form the pattern as well as the pattern mount.

"Taking them in the order indicated, the first method is applicable to both wood and metal patterns in great variety and, briefly, may be described as follows:

"One side of the pattern first is molded in composition and the parting line and runner formed. A transfer of this drag match then is made also in composition, the latter forming the cope match. Then the pattern itself is set back into the first impression where it is fastened rigidly with suitable screws. It is not necessary to make a preliminary sand mold. Therefore, there is no sand to clean off after the matches are finished. I am not now speaking of a split pattern, but a one-piece pattern with an irregular cope face and the idea is to make a cope and drag matchplate on which the cope and drag mold respectively can be rammed.

*Filling the Frames*

"The drag pattern frame, designed to hold the compound and provided with suitable guides to fit the flask pins is secured to the board by an intermediate wood frame that will bring the upper edge of the iron frame in proper relation to the parting line of the pattern. The pattern should rest level on blocks of end grain, shellaced, hard wood to allow about ½-inch of composition beneath the lowest point on the pattern. The pattern is attached firmly to the pattern board by a number of long screws which pass through the supporting blocks and enter drilled and tapped holes in the lower edge of the pattern. Small wedges will be found useful in locating the pattern upon the blocks in such a manner as to insure a clean vertical draw. After mixing just a sufficient quantity of the compound for the work in hand, the material is tucked and rammed under and around the lower edge of the pattern until the frame is filled. The parting then is made as in ordinary molding practice and then the pattern is unscrewed and removed. The blocks remain in the composition. The parting is gone over carefully and slicked, after which the match is set away in a dry place at a temperature of 70 to 80 degrees Fahr. for from 12 to 24 hours. When the drag match has dried, and necessary cope core prints are set in loosely for transfer to the cope match The match face is dusted lightly with parting compound through a fine bag. Tumbler dust is recommended for this purpose as it does not absorb oil and stick to the face of fresh mounts.

"The cope frame, also provided with suitable guides, is set in place on the drag mount and if the irregular parting is too deep, a wood frame is clamped on top of it. A fresh batch of compound is placed inside the frame and after it has been rammed, the surplus material is scraped off flush with the top. A flat board is bolted on the back and then both parts are rolled over. The drag match is removed and the cope match is set away and allowed to harden over night. The pattern is returned to the drag match and screwed permanently into place, after which it is advisable to apply two coats of shellac varish to the surface of the mounts, smoothing lightly with fine sand paper between coats. Metal matchplates and gated patterns readily are adapted for use on a 2-plate machine by following the same procedure. The method produces an accurate pair of mounts without injuring or altering the matchplate or card of patterns. Pattern mounts are equally valuable for bench, floor or squeezer molding. For such use the pattern merely is set, not fastened, into the drag match and no cope match is required.

"If it is considered necessary or desirable to make plaster of paris or other liquid compound, matchplates or follow boards for some particular job the same rigging may be employed by changing the method slightly. A drag containing the pattern is filled with sand, rammed, rolled over and a parting made in the usual manner. The frame destined to be used later for a drag match then is placed in position and filled with liquid plaster through a hole provided in the backing board for that purpose. After the plaster has set, the frame is lifted off, turned over, cleaned, painted with vaseline and then the cope frame is set on and filled with plaster in the same manner. After the plaster has set, the two frames are separated, cleaned, shellaced and placed in service as drag and cope matchplates respectively.

"Laying aside for the moment the relative merits of composition and metal matchplates, circumstances sometimes may suggest to the foundryman the advisability of preparing matchplates for split patterns without going to the expense of providing a master pattern to compensate for shrinkage. Plaster sometimes is used for this purpose, but there are compounds on the market which it is claimed give satisfactory service. An ordinary split pattern is molded in the usual manner and after the patterns have been drawn, the gates cut and the mold finished, a frame is placed over each face and poured full of compound. Nails or small strips of metal are placed at any delicate point that needs reinforcing and after the compound has set the flasks and sand are removed leaving two pattern mounts with the half patterns in their proper relative position and forming integral parts of the mounts. Plaster also is used extensively in making small intricate patterns and coreboxes, for instance valves and plumber's castings and the methods pursued present many points of interest."

"If it is all the same to you Bill" I said "I move we put away the tools, punch the clock and call it a day. If I hear any more about plaster I shall feel the grit in my teeth. Besides I want to go home and send that billet doux to my oratorical young friend who was in such a hurry that he inadvertently, I am am sure, forgot to enclose postage."

"Forgot my eye" said Bill. "The only thing one of those birds never forgets is himself."

## Build Iron Foundry at the Gateway to the Pole

A small gray iron foundry is now being built at the whaling station at Grytviken on the island of South Georgia in the Antartic ocean. From the standpoint of its location this foundry is one of the most interesting which will be constructed this year. South Georgia is called, the gate way of the Anarctic, and in addition to being a port of call for whaling and trading ships, it also serves as an advanced base for exploration parties. It was frequently used for this purpose by Sir Ernest Shackleton, the great English explorer, whose recent death in the Anartic was followed by the decision to inter his remains and to erect a monument at South Georgia.

The foundry which is now under construction at Grytviken although small will be completely equipped with facilities for making iron and brass castings up to fairly large sizes. The construction of the foundry will considerably increase the ship repair facilities at Grytviken. A cupola, ladles and other equipment for this foundry were furnished by the Constructional Engineering Co. Ltd., Birmingham England.

## Purchase Seattle Shop

The Tennent Steel Casting Co., Tacoma, Wash., has purchased the property of the Aurora Foundry Co., Seattle which will be operated by the management of the Tennent company. The officers are M. G. Tennent, president and manager; D. D. A. Outcalt, treasurer; J. E. Sinclair, secretary.

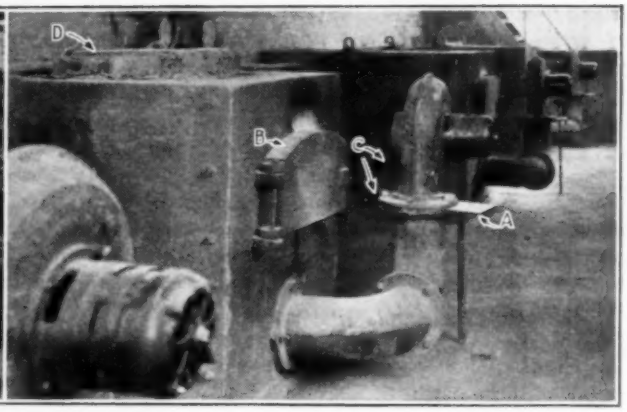



Fig. 1—Cores for boilers are dried in ovens fired with portable furnaces  Fig. 2—An individual furnace is attached to each oven and every furnace has its own blower

# Forced Draft Unit Fires Core Oven

THE usual practice of making the firebox integral with the core or annealing oven has been modified by the Mayor Patent Fuel Saving Furnace Co., which has designed a self-contained portable furnace to be attached to ovens. This may be attached to an oven already installed by making a few changes, or it may be connected with an oven specially designed to be adapted to it. It is stated that the furnace will heat ovens up to 2500 cubic feet in volume. It is intended that one furnace be attached to each oven.

Fig. 3 is a sectional view of a furnace attached to an oven, while Figs. 1 and 2 show the front and rear, respectively, of core ovens in the new foundry of the Weil-McLain Co., Michigan City, Ind. The fans used are specially designed for this furnace by the B. F. Sturtevant Co., Boston. Air is forced under the grate bars and gives a steady pressure in the oven. The volume of air is regulated, according to the amount of fuel in the firebox and the condition of the oven, by the gate at *A*, Fig. 2. The fan, which is driven by a ½-horsepower motor, furnishes 600 cubic feet of air per minute at 2 to 3 inches water pressure. The grate area is only 6.25 square feet.

Due to the forced draft, it is claimed a low grade fuel may be used, either coke or coal. This is introduced through the fire door, *B*, Fig. 2. Ashes are taken from two openings in both sides of furnace, partly shown at *C*, Fig. 2. The finer ashes are drawn from the lower opening and the clinkers removed from the upper one. An opening is provided at the top, closed by the cover *D*, Fig. 2. This is used for feeding coal to the furnace when a hopper is installed. When the fuel is fed through the fire door, the top opening is used to let in a bar for breaking up any clinkers which form.

As may be noted from the drawing, Fig. 3, all parts of the oven and furnace are above ground. The internal heat flue is contained in the 18-inch side walls and has openings at intervals along its entire length. Thus the air is blown toward the center of the oven, rises to the top, and, as it cools, falls to the bottom and is carried off through the ports at the end

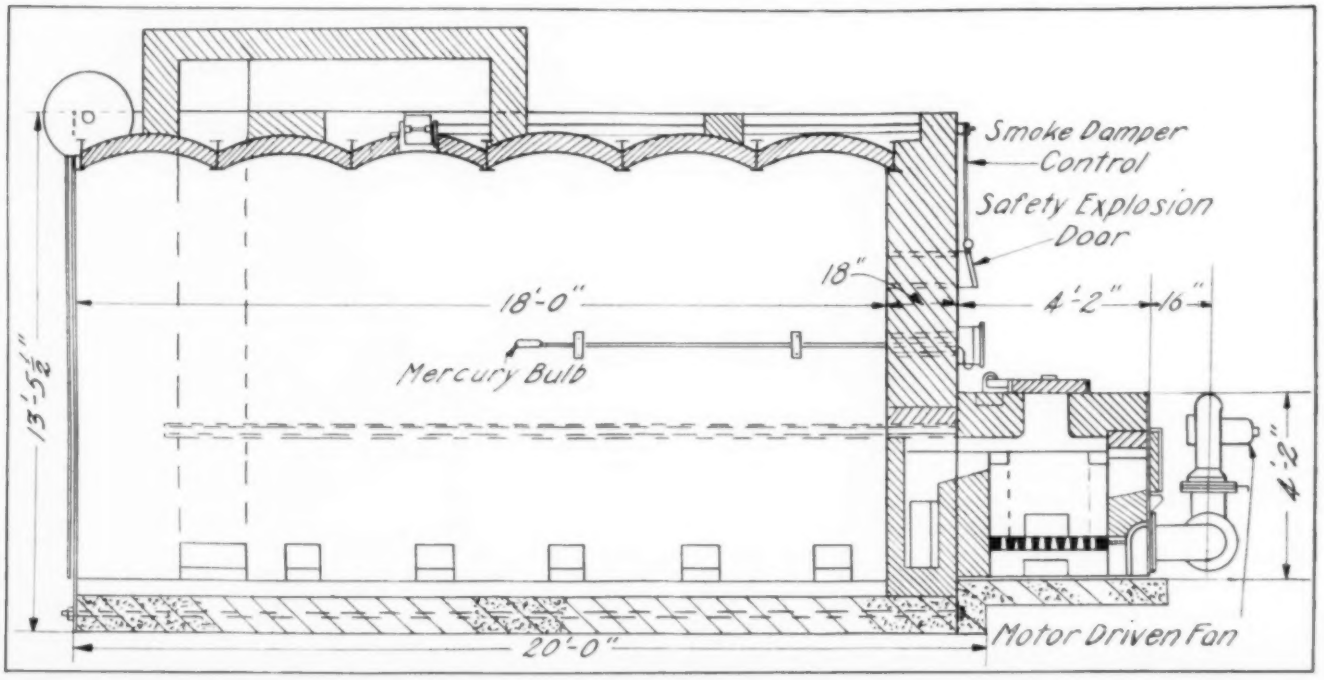



FIG. 3—BOTH THE HEATER AND THE OVEN ARE ENTIRELY ABOVE THE FLOOR LEVEL—THE INTERNAL HEAT FLUE IS CARRIED IN THE 18-INCH SIDE WALLS

opposite the furnace. Efficiency in the operation of the furnace and oven is increased by the use of recording thermometers which are shown attached to the oven in Figs. 3 and 2.

With this system of heating no central blowing system is necessary as each oven has its own blower attached to the furnace, and controlled by an electric switch located on the wall at a convenient position. Operating parts are fully enclosed.

# Shows Effects of Fusion Welds on Metal

BY H. S. RAWDON

THE well informed metallurgist understands and appreciates the type of metal with which he is dealing in a fusion-weld. However, this can hardly be said in general of the designer and user of metal structures involving welding as one of the fundamental requirements.

In the accompanying table are summarized the mechanical properties of low-carbon cast steel prepared by the thermit process, and by arc-fusion. Cast steel formed by fusion in the gas-welding process essentially has the same properties as those from arc-fusion, usually, however, with considerably higher ductility. The results given in the table indicate there is no reason why metal approximating cast steel in its mechanical properties cannot be produced by any of the fusion welding processes.

The properties of cast steel may be materially improved by relatively slight changes in the composition of the metal. This is illustrated in the accompanying table which shows that an increase in the manganese content produces an improvement in the mechanical properties of a steel casting. In welding by the thermit process, such changes of composition are produced by making the proper additions to the initial thermit mixture, and it has been found by experience that such additions as titanium produce weldmetal of improved quality. The use of ordinary nickel steel wire for the gas and arcwelding of low carbon steel was pointed out by Mr. Miller to be an important application of the principle. The opinion of the writer is that in this direction improvements in fusion welding are most promising since the application of heat treatment for the improvement of fusion welds by grain refinement such as is used for ordinary steel castings is not practicable commercially. Two recent changes in welding practice along this line which are worthy of mention are the use of monel metal for cast-iron welding and the use of iron for the welding of monel metal and other nickel alloys.

The occurrence of initial stresses in castings is so common a phenomenon as to be regarded by some as a necessary though undesirable, accompaniment of every casting. While this probably is far from being the case, it is undoubtedly true that every commercial casting of complex design, particularly one containing *constrained*

Discussion of a paper entitled "Fusion Welding," presented by S. W. Miller, Rochester Welding Works, Rochester, N. Y., at the American Iron and Steel institute meeting, New York, Nov. 18, 1921. Mr. Rawdon is physicist, United States bureau of standards, Washington.

## Properties of Cast and Fused Steel Produced

| Specimen No. | Material | Tensile Properties: Elastic properties, Pounds per square inch | Tensile Properties: Ultimate strength, Pounds per square inch | Tensile Properties: Elongation, Per cent | Fatigue-resisting Properties: Reduction of area, Per cent | Fatigue-resisting Properties: Maximum fiber stress, Pounds per square inch | Fatigue-resisting Properties: Number of revolutions | Fatigue-resisting Properties: Results | Toughness kg. m |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Cast steel: Carbon 0.10, manganese 0.23 | 23,900 Y.P. | 50,000 | 35 (2-inch) | 47.8 | ..... | ..... | ..... | 2.5 (Fremont) |
| 2 | Same as 3.3 hours, 900 degrees Cent. air cooled in 40 minutes | 28,750 Y.P. | 55,400 | 38.5 (2-inch) | 67.0 | ..... | ..... | ..... | 20.0 (Fremont) |
| 3 | Cast steel: Carbon 0.23, manganese 1.07; quenched 900 degrees Cent., water tempered 680 degrees Cent. | 44,400 Y.P. | 67,200 | 14.2 (2-inch) | 31.3<br>.... | 28,270<br>38,870 | 10,475,000<br>619,700 | Broke | 32.0 (Fremont) |
| 4 | Cast steel: Carbon 0.21, manganese 1.17; treatment same as No. 3 | 71,650 Y.P. | 91,900 | 20.4 (2-inch) | 50.2 | ..... | ..... | ..... | 21.0 (Fremont) |
| 5 | Cast steel: Carbon 0.11, manganese 0.88 | 26,000 Y.P. | 58,500 | 25.9 (a) | 30.0 | ..... | ..... | ..... | 3.64 (Charpy) |
| 6 | Same as 5, annealed 920 degrees Cent. | 37,000 Y.P. | 60,000 | 29.9 (a) | 59.2 | ..... | ..... | ..... | 17.16 (Charpy) |
| 7 | Thermit steel composition not stated | 54,420 E.L. | 80,500 | 23.5 | 42.5 | ..... | ..... | ..... | ..... |
| 8 | Arc-fused Steel (before) (after)<br>Carbon ..... 0.002 0.017<br>Manganese ..... 0.038 0.023<br>Nitrogen ..... 0.004 0.13 | 23,800 P.L.<br>35,000 Y.P. | 50,650 | 7.5 (2-inch) | 12 | ..... | ..... | ..... | ..... |
| 9 | Arc-fused Steel (before) (after)<br>Carbon ..... 0.15 0.025<br>Manganese ..... 0.47 Tr<br>Nitrogen ..... 0.003 0.14 | 27,250 P.L.<br>34,450 Y.P. | 51,550 | 9.5 (2-inch) | 9 | ..... | ..... | ..... | ..... |
| 10 | Same as 8 stressed perpendicularly to deposition layers | 22,500 Y.P. | 39,500 | 4 (2-inch) | 3 | ..... | ..... | ..... | ..... |
| 11 | Arc-fused steel, from covered electrode | 40,700 E.L. | 56,800 | 15 (8-inch) | .... | 28,500<br>25,600<br>24,850<br>24,200<br>24,200<br>20,600 | 321,000<br>492,100<br>5,570,000<br>11,000,000<br>731,000<br>1,413,000 | Broke in fillet<br>Broke in fillet<br>Without fracture<br>Without fracture<br>Broke just outside fillet<br>Broke 0.3-inch from fillet | ..... |
| 12 | Same as 11 annealed | 26,000 E.L. | 52,200 | 19 (8-inch) | .... | ..... | ..... | ..... | ..... |
| 13 | Arc-fused steel, stressed parallel to deposition layers | 28,250 E.L.<br>34,630 Y.P. | 56,800 | 17.4 (2-inch) | 27.3 | ..... | ..... | ..... | ..... |
| 14 | Same as 13, stressed perpendicularly to deposition layers | 22,125 E.L.<br>29,125 Y.P. | 42,180 | 4.6 (2-inch) | 11.4 | ..... | ..... | ..... | ..... |
| 15 | Same as 14 after being forged from (1½-inch)² to (1-inch)² | 28,000 E.L.<br>31,600 Y.P. | 56,900 | 27.6 (2-inch) | 59.6 | ..... | ..... | ..... | ..... |

(a) Gage length equals 10 times diameter. Y.P., yield point; E. L., elastic limit; P.L., proportional limit.

members, is sure to have internal stresses of relatively high magnitude. If fracture does not occur during the cooling of the casting, it often does when the piece is subjected to a slight external stress, either during testing or in service. In fusion welds, the conditions for setting up high internal stresses are favorable, much more so than in the usual casting process, so that the state of the material with respect to stresses is one of importance. The chances for irregular and uneven cooling by which stresses of high magnitude often result are favorable in fusion welding. The conditions obtaining in the simple case of oxyacetylene cutting of steel under no external constraint whatever may sometimes be sufficient to cause cracking of the metal. Specimens illustrating this, recently submitted to the United States bureau of standards for examination, indicated that in the case of heavy sections cracks were found frequently. This of course was on account of the chilling action of the heavier mass of metal. In actual practice, particularly in welding rigid or constrained members the conditions for initial stresses to arise are favorable. The differential contraction of the molten part upon solidification with respect to the adjacent solid metal, the variations in the rate of cooling of the welded piece, the complications introduced, in the case of iron and steel, by the expansion changes which accompany the critical transformations characteristic of these materials, all combine to render a condition of equilibrium with respect to stresses an impossibility.

*Welding Stresses Unknown*

Only scant information is available concerning the magnitude of these welding stresses. Any such stress must be less than the elastic limit, otherwise the material would yield somewhat and the magnitude of the stress be lowered. The absolute value of the stress is of less importance than its magnitude relative to the properties of the metal when hot. In addition to the hot-shortness of weld steel, caused by the oxide contaminations, it may be pointed out that all grades of carbon steel and many alloy steels whether sound or unsound, possess the peculiar property which has been termed *blue brittleness*, because it manifests itself in the temperature range corresponding to the blue temper color. In this range the tensile properties, ductility, and notch toughness of the metal are less considerably than they are at a slightly lower or at a slightly higher temperature. These properties, the *hot shortness* of certain steels and the *blue brittleness* of most steels cause the cracking in fusion welds resulting from internal stresses. Although the stress may actually be below the elastic limit of the cold material, if it exceeds or is equal to the lowered elastic limit in the blue brittleness range, cracking may be expected to occur.

Measurements made at the bureau of standards of the initial stress in cast manganese bronze which had been subjected to a burning-in process indicated a stress somewhat less than the proportional limit of the material as measured at ordinary temperatures. The stresses originated in the repairing process of burning-in, a form of fusion-welding, and their magnitude would not indicate that their presence was a serious problem. However, large castings of this material used in the construction of the Catskill aqueduct, which had been subjected to the repairing process of burning-in, developed cracks after several months of atmospheric exposure. This case illustrates another possible source of trouble arising from internal stresses in welds. In materials, such as most of the copper-rich alloys, which are subject to corrosion or season cracking, the stress resulting from welding though not high enough to cause trouble by itself, may be sufficient to permit cracking to occur when the material is subjected to the proper corrosive conditions as appears to have been the case of the manganese bronze casting just cited. Although steel and iron are not subject to season cracking ordinarily, the complications introduced by corrosive service conditions should be considered whenever welded articles are to be used in such service.

Enough has been said to emphasize the fact that the building-up of internal stresses in a fusion-welded article is a necessary accompaniment of the process. However, as Mr. Miller has pointed out, by proper preliminary measures, preheating, etc., these stresses can be distributed throughout a large volume and so produce no immediate undesirable result. In the finished article they may be eliminated entirely by suitable low-temperature annealing.

The problems connected with fusion welding may be conveniently summarized under the following headings:

Production of sound cast metal by the elimination of seams, layers, holes and, as far as possible, by eliminating oxidation.

Improvement of the properties of the cast metal by the choice of suitable compositions since the improvement by heat-treatment is not practicable generally.

Allowance for the unavoidable internal weld stresses during welding so that they are not concentrated at the weld and whenever practicable the elimination from the article after the welding has been completed by proper annealing or other suitable treatments.

## When To Start the Blower

*By Pat Dwyer*

*Question:*—After charging our cupola we have been accustomed to closing the tuyeres and allowing the fire to burn from an hour to an hour and a half before putting on the blast. Is that necessary? Do we get better iron that way than if we were to put the wind on immediately after the cupola is charged?

*Answer:*—If the cupola is charged properly, that is if the bed is the proper height, the iron and fuel ratio as it should be and if the blower is delivering an ample volume of air, you will get as good iron by starting the blast immediately after the furnace is charged as you would by holding it for an hour or more.

The only advantage gained by holding the cupola after it is charged lies in the fact that the first iron will come down a few minutes quicker after the blast fan is started. This is because a certain amount of combustion has taken place through the natural draft and after the blast is started it does not require so long to raise the coke bed to the incandescent stage. In an emergency the writer has started the blast after the first charge was placed in the cupola and then continued charging as usual with perfectly satisfactory results.

## Appoint Local Committees at Rochester

Norman Van Voorhis, Galusha Stove Co., Rochester, N. Y., has been appointed general chairman to head an executive committee of eight Rochester business men who will have charge of the local arrangements for the American Foundrymen's association convention. This executive committee has completed its organization by selecting a chairman for all of the local convention committees. A hotel committee has been formulated and reservations may be made at this time either directly with the hotels or through the secretary of the hotel committee, Joseph Smith, Powers Hotel, Rochester, N. Y. The hotels have been requested not to make reservations in excess of six in number until these reservations have been passed upon by the committee. An up-to-date record of all reservations will be made.

# Laboratory Aids Foundry Operation

## Laboratory Built by a New England Malleable Iron Company Proves Helpful in Controlling Mixtures—High-Sulphur Coal Used in First of Heat

A LABORATORY in connection with a foundry may be made to serve three purposes; control of the melt; checking raw materials against specifications; and for experimentation. In the routine foundry operation, the first service is the most essential and is the principal reason for maintaining a laboratory. However, the value of the second and third field also is often large, and occasionally a discovery made in the laboratory serves to revolutionize some feature of the plant operation.

The Arcade Malleable Iron Co., Worcester, Mass., recently has finished construction of a new laboratory which is so complete in its facilities and at the same time so relatively inexpensive as to make it a model type for individual foundry laboratories. It is a combination chemical and physical laboratory, planned to take care of all analyses and tests needed in foundry practice and in research work. The building was constructed during the recent business depression by men employed in the foundry, many of whom the management desired to keep despite the fact that the foundry operations were slack.

The building which is of concrete block construction has two floors, the lower one devoted to physical testing and the upper chemical work. The upper floor has two rooms. The larger one, 18 x 21 feet, is used for general laboratory work. The other room, which is 11 x 18 feet, is used for a combustion and balance room as well as an office. Fig. 1 shows one corner of this room where the balance and carbon train are located. The bench containing the carbon train has a removable section at the right hand side which permits the easy placing and holding of an oxygen tank.

The floors are of hard wood and the bench tops in the main laboratory are 3/16-inch asbestos board, painted with a black acid-resisting paint. The bench for the carbon train, in the outer room, is also covered with asbestos and painted in the same way. The balance has a hard maple top. The construction of the hood in the larger room is somewhat unusual. Sliding windows on each side give double access, as shown in Fig. 2. A brick chimney which extends out through the roof has openings at both the lower part and the upper part of the hood to take off the heavy and light gases. The entire hood except where the chimney forms a part of the wall is lined with 3/16-inch asbestos board, painted with black paint as in the table tops.

The equipment is the same as is used in nearly all small laboratories including an electric muffle furnace for igniting precipitates.

Some idea of the use to which this laboratory is put may be gained from following through a few of the controlling operations. Hard-iron bars are cast from each heat. These are drilled to obtain samples which are taken to the labortaory for analysis. The results of the analysis of one heat are reported to the works manager, or the melter, before the following heat is tapped, thus making it possible to regulate each succeeding heat according to the chemical analysis of the previous heat. The coal pile is staked off in sections and numbered, each being an estimated day's supply. These sections are analyzed several days before they are used, which permits regulating the manganese in the heats according to the sulphur content in the coal. If a section of the pile shows up unusually high in sulphur, that particular section will be used in the first part of the heat before the iron has reached the molten state, and when a minimum of the sulphur in the coal is absorbed by the iron. The manganese in the iron should be approximately two and one half times the sulphur in order to combine with all of the sulphur to form sulphide of manganese. By weight, 55 parts of manganese and 32 parts of sulphur produce 87 parts of manganese sulphide. If the manganese is under this ratio, all the sulphur will not be removed and the castings will be somewhat harder to machine. This would cause a decrease in the tensile strength and the elongation. Silicon and carbon also are closely controlled.

The physical laboratory enables the foundrymen to guarantee the strength and ductility of his iron. It is planned to include microphotographic equipment as part of the physical section.

The cost of a foundry laboratory building, along the lines of that just

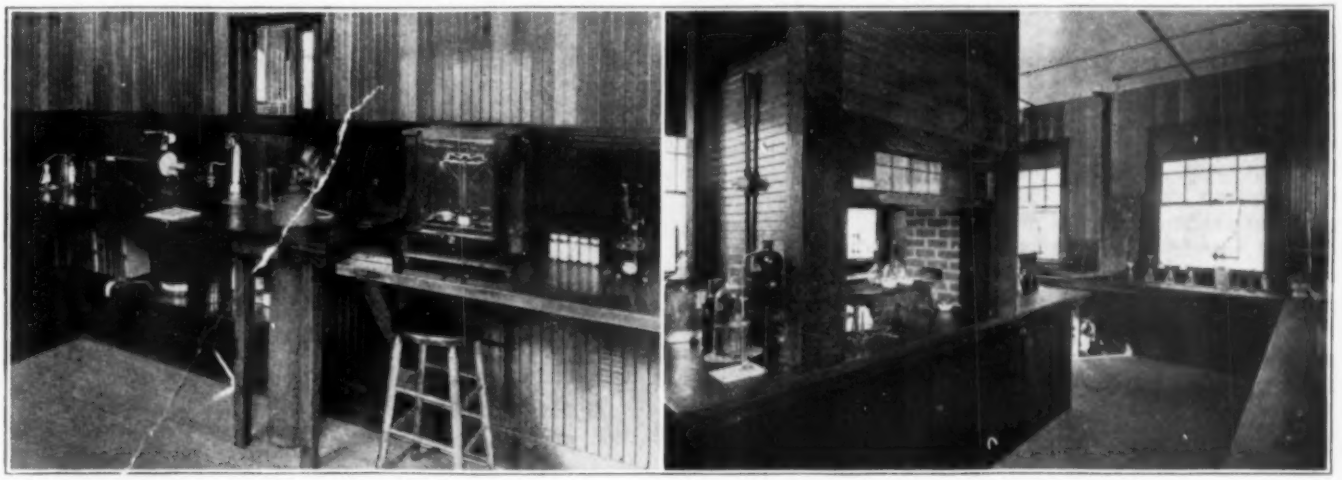


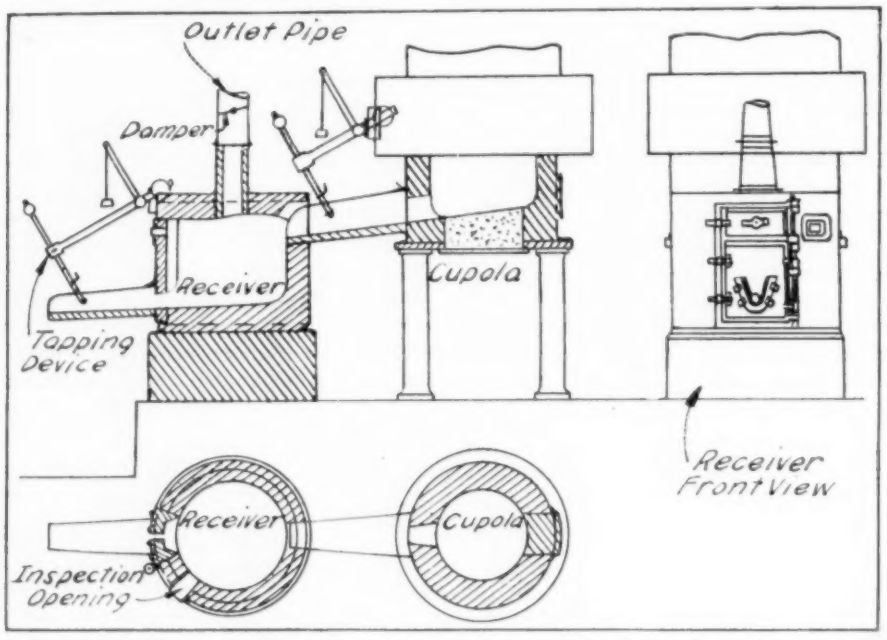
FIG. 1—THE COMBUSTION TRAIN IS LOCATED IN THE ROOM WHICH ALSO SERVES AS A BALANCE ROOM AND AN OFFICE
FIG. 2—THE HOOD IS IN THE CENTER OF THE MAIN LABORATORY AND IS SURROUNDED BY THE WORK BENCHES WHICH ARE AGAINST THE WALLS

completed at the Arcade Malleable Iron Co. plant should not exceed $7500, and the value of such an addition only will be fully realized after its functions are gradually developed and full advantage is taken of control possibilities.

# Germans Desulphurize Iron in the Ladle

BY HUBERT HERMANNS

GERMAN foundries, like others all over the world, are constantly battling with the sulphur problem, but during the past few years the difficulties arising from this source have been accentuated. A gradual increase in the sulphur content of castings has taken place, mainly owing to the increased use and reuse of scrap during and since the war. As a result, considerable work recently has been done in Germany on the development of various desulphurizing processes. One of these is that of Walter. In this process the sulphur is extracted from the iron after it has left the ladle while tapping. In order to prevent a fresh absorption of sulphur from the slag it is important that the furnace slag should not be allowed to get into the ladle. A strong reaction begins as soon as the desulphurization powder comes into contact with the molten iron. The ladle is then allowed to stand a certain time until the desulphurization process has advanced sufficiently. The period of desulphurization is dependent upon the sulphur content of the tapped iron, the sulphur content required in the finished iron, and the metal section of the castings. Various trials seem to indicate that the sulphur may be reduced from 0.165 per cent to 0.043 per cent without undue difficulty.




ARRANGEMENT OF CUPOLA AND RECEIVER FOR DESULPHURIZING

cupola. The first experiments on a large scale were carried out at the large foundry of the Thyssen company at Mulheim-Ruhr. After these trials the Borsig foundry at Tegel, near Berlin, also took up the process. Their example was followed by a number of smaller foundries. In this process a highly basic slag consisting of various alkalis, supplied by the inventor, is formed on the surface of the molten iron, bringing about a powerful reaction, while a degasification of the iron is effected at the same time.

At the Thyssen foundry the bath is desulphurized in the ladle. A portion of the desulphurizing medium is placed in the bottom of the ladle before tapping and the remainder is added in the

In the Borsig foundry, which chiefly produces locomotive cylinders, air compressor and other machinery castings, efforts were at first made to reduce the sulphur content in the iron by raising the manganese in the charge and augmenting the limestone fluxes. However, these efforts were without much success. Patented desulphurizers later were employed. But the abstraction of the thin, fluid slag was difficult and it was found that a portion of the slag might easily remain on the bath and thus get into the molds. The ladle method of desulphurization was therefore abandoned and the process was carried out by placing in front of the cupola a cylindrical receiver as shown in the accompanying illustration. The receiver is provided with an outlet pipe closed by a damper through which the gases and vapors formed can escape. The melting operation of the cupola itself is in no way altered. From time to time the slag is tapped from the cupola in the usual fashion. The receiver is provided with two doors. The lower door carries the spout, the upper door serving to fill up the joints between the door and lining after the lower door is closed. The receiver, which was first provided with sand lining, has a capacity of 3 tons. Later it was given a tamped lining of grain magnesite mixed with 10 per cent of clay. On a third trial a tamped lining of clay mixed with tar was employed.

The results of the trials showed that a sand lining has a detrimental influence, and that a lining of magnesite grains mixed with clay is better.

## Mark Patterns According to Definite Plan

*By M. E. Duggan*

Marking and recording patterns, coreboxes, strikes, match boards, etc., is a job that should not be intrusted to a boy or a careless workman. Neither should the location of the patterns in the pattern vault be known to only one man, irrespective of whether he has a phenomenal memory or not. The fact that one employe can go into the pattern vault blindfolded and lay his hands on any given pattern is of little help if some day he should happen to be absent and certain patterns are wanted in a hurry. It is not uncommon on such an occasion for the foundryman to go into the vaults to search for the pattern. After examining three or four approximately alike he decides that a certain one is the one he wants and then he is not sure whether there is a special corebox or if stock core was employed the last time the job was made.

Patterns should be marked in a legible manner and according to a definite system with every part listed and its location accounted for. There should be a definite location, indicated by floor, section and shelf for each pattern and all this information should be on record, either in book form or leaf filing cabinet, so that any employe at any time

may walk into the pattern storage and find any pattern required.

Leave no room for guess work. Use figures and letters of such a size that they are not only legible on the pattern but also will appear legibly on the casting. Frequently this latter point is given no consideration and the figures and letters are placed on a part of the pattern where they are effectually concealed when the casting takes its place in the general assembly. The importance of clearly and intelligently marking and recording patterns is illustrated by the following examples:

A casting known as a combination gear and pitman wheel on a certain machine was broken and a new one was ordered from the factory where the machine had been built. The casting had been made from an altered pattern marked 100 *A*. The original pattern had been designed No. 100. In placing the *A* on the altered pattern the pattern maker used a ⅜-inch letter instead of a ½-inch letter to correspond with the figures. The ⅜-inch letter was quite legible on the pattern but on the casting its identity was lost and it appeared simply as a small lump after the number. The result was that instead of ordering a casting marked 100 *A*, the order simply read 100 and the mistake was not discovered until the machine had been taken apart. Molders usually do not take time to patch letters or figures in a mold, in fact no one seems to pay any particular attention to them until a mistake has been made.

An exception to this general rule may be observed among the makers of electrical machinery. On this class of castings the identifying letter and figures are placed on the patterns in such a manner that they are readily apparent after the machine has been assembled.

Two bevel gears were needed to replace a pair that practically were worn out. The millwright was instructed to place the order in time to have the new pair on hand ready to be installed before beginning to dismantle the old set. When the millwright attempted to secure the pattern number of the gears he found that it was cast on the inside of one of the arms and out of sight. To secure the necessary information he had to slip the gears off the shaft and then replace them pending the arrival of the new wheels.

In the first instance the fault clearly was the patternmaker's. He should have known that a small letter would not show up on a rough casting. In the second instance the fault lay either with the drafting office or the pattern shop office. The patternmaker fastened the letters on what was designed as the drag side of the pattern, the side on which letters usually are fastened. He was in no position to know what position the casting was to assume in a finished installation. That point should have been taken care of and a note placed on the working drawing directing the patternmaker's attention to the fact that the pattern letters should be attached to a certain well defined space.

# Indexes Valuable To Keep Tab on Labor

BY HERBERT R. SPENCER

ONE requisite of a successful employment office is the proper adaptation of card index systems. Too many firms, especially the smaller ones, rely upon a mere note in a memorandum book as the complete information necessary in the induction of a new employe and if the name ends in *ski* it is left out and Mike or Tony substituted. The very first point of contact is the name, and if that is considered of superficial importance the impression is given to the workman that every other human contact point is superficial.

The method of discharging an employe is important—he must be sent away with his sense of justice admitting the reasons for his discharge to be fair and with a clean taste in his mouth. In hiring an employe it is important to see that he is placed properly. When laid off, an employe frequently sees grounds for discontent and spreads them. A discharged employe nurses his grievance outside the plant, but one laid off temporarily or permanently, justly or unjustly, circulates his complaint among the working force.

The fair decision as to whom to lay off can be found in the employment office files, if they have been ordered properly, and when slack times come there is a basis for judgment in the old dilemma of which man shall be laid off. The fuller the files are, the more satisfactory will be the work of the employment department.

In the accompanying table is given what may be called a *logical maximum* of information to be entered on the employment card. With this complete, a proper employment manager can be confident of administering justice, and each employe will feel that the company is interested not only in his work, but also in his family, his future, and his life and living.

The number of indexes and cross-indexes is important. It is patent that information is useless if it is indexed improperly, and to be able to use the knowledge placed on the employment card it must be systematized. The maximum number of files will include indexes of name, shop number, physical examination, absentee, aspiration, secondary profession, and the life insurance file.

The alphabetical file of names must be crossed with the numerical; that is, both the number and the name must appear on both cards; this point is indispensible. The best arrangement of employe numbers is in such a way that each department is allotted a certain series of numbers; for example, in the United States Navy the man whose number is 512 is the twelfth man in the fifth division, or work section.

The record of the physical examination, if not placed on the back of the employment card, may be filed in the same cabinet; however, if there is a doctor's office in the plant a separate file of these cards may be kept there.

An absentee file is for the convenience of that member of the employment staff who is charged with the duty of calling on those who are absent. It prevents continual fingering of the employment card and makes systematic the records of absenteeism. Each card records every absence and the reasons therefor. This file is arranged alphabetically.

The aspiration file is arranged by departments or by professions. The use of this file ought to form a vital part of the work of the personnel supervisor. If a vacancy occurs, the opportunity usually is offered first to another employe if eligible. Many a young man still filled with ambition is breaking his back as a molder's helper while he is convinced that, given the chance, he could make good as a machinist; many a carpenter longs to be a patternmaker; the misfits are myriad. It is the purpose of this file to assist the personnel supervisor in finding these and giving them opportunities.

The secondary profession file is in-

The author formerly employment manager, National Foundry Co., Erie, Pa.

dexed by trades. If an emergency call comes, for example, for the information is at hand by which the gap is filled without loss of time.

The life insurance file, showing which employes are insured and for what amounts, is required by some insurance companies.

In addition to the files already mentioned, a list by nationalities occasionally is kept by the Americanization director. The job specification file, demonstrating the demands of each particular job in the plant, is maintained by some employment managers. Its value is problematical.

The number of dead files to be preserved is a question. If the entire number of files listed above were in use, it would be rather a task to maintain each one separately as a dead file after the cards have become inoperative.

Probably the simplest method and the most effective is to file the numerical cards in one file, and in another to place the alphabetical cards (which probably will be the main employment card with the employe's complete history) together with the records of physical examinations. The information on the aspiration, secondary profession, and absentee cards should be recorded on the employment card which, as just stated, would probably be the alphabetical, and the originals destroyed. The card from the life insurance file could be sent to the insurance company as notification of the release of the employe, and the nationality file card could be destroyed.

With proper system, the card index can be of inestimable assistance to the employment manager, the personnel supervisor, the Americanization director, the insurance secretary, and the welfare worker. Improperly kept, it becomes a menace to the peace of mind of everybody. The methods of modern efficiency demand instant, complete, and correct information regarding every employe, and in no other way can this end be achieved than by properly maintained card index systems.

## Maximum Information To Be Entered

Name.
Shop number.
Department and job in the department (unless this is told by shop number).
Sex (if necessary).
Nationality.
Address (upstairs or downstairs, etc.).
Telephone (necessary for foremen).
Age and birthday (some firms remember birthdays).
Family (wife, children, ages of children, location. Many foreigners have their families in the Old Country, and if so their address should be known).
Nearest living relative (and address, especially if there is a relative in the plant to be notified in case of accident).
Home-owner? (clear or mortgaged?).
Citizenship (first or second papers and date eligible. This knowledge is prerequisite to Americanization work).
Speak English?
Religion.
Physical examination (usually a separate card, or the back of the employment card, is used.
Date employed.
Recommended by....
Hired by.....
Rate of pay.
Advancements (with dates).
Date discharged.
Discharged by.....
Reasons (in full).
Re-employable?
Capability per cent (skill).
Desirability per cent (skill plus steadiness plus personality. A percentage system of grading men is not difficult to work out, especially where the system of piece work is used).
Absenteeism per cent. (The annual percentage of days off reflects the steadiness of a workman. Special reasons, such as prolonged illness, should be noted.)
Employed here before? (and dates).
Three previous employers (and dates. References should be investigated carefully).
Member of the company relief association?
Member of the company athletic association?
Amount of life insurance granted.
Date.
Beneficiary. (This refers to group life insurance.)
Locker number.
Safety appliances issued (such as goggles, helmets, asbestos gloves, tools, etc.)
Secondary profession. (The fact that a lathe hand may be also a plumber is a valuable piece of information.)
Aspiration (the line of work the employe hopes to enter. Very important).

---

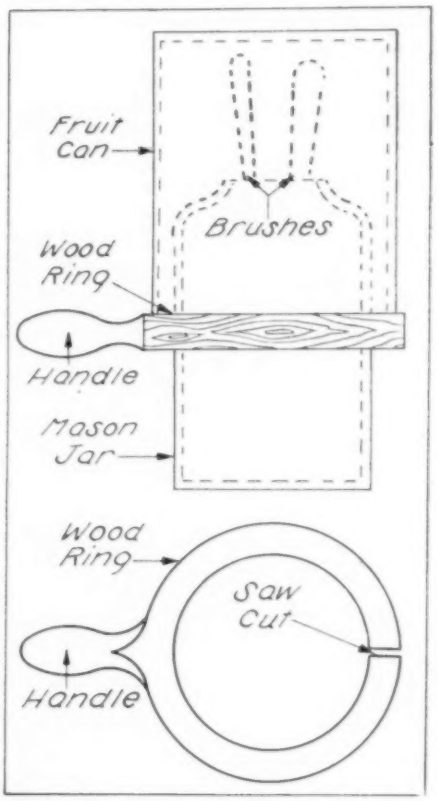
The domestic shipments of high-grade manganese ore, containing 35 per cent or more metallic manganese, amounted to about 13,000 gross tons in 1921, of which more than 10,000 tons was shipped from Montana, according to H. A. C. Jenison, of the United States geological survey, department of the interior. The shipments of ore containing 10 to 35 per cent of manganese amounted to about 72,000 tons, most of which was shipped from Minnesota. The shipments of manganiferous and ferruginous manganese ore were about 14,000 tons.

## A Handy Shellac Holder

*By M. E. Duggan*

Considering the fact that shellac varnish is shipped with no deterioration in 10-gallon tin cans it is hard for the patternmaker to understand why it turns black when spilled into a tin can for use in the shop. Having heard that the tin can was the cause of his trouble a patternmaker ordered two copper cans, made at a cost of $12, to hold his shellac. One can for the black and the other for the clear varnish. They were no better than the tin cans. The shellac did not turn quite black but it presented a dirty appearance when applied to a nice clean pattern surface.

Some patternmakers seem to prefer some freak form of outfit in which to hold their shellac. In a short time the entire outside of the container including the cover, brushes and handles is covered with shellac. Usually the cover is a neat fit, so neat in fact that after it has been closed for a short time it is necessary to employ a pry to remove it. Occasionally and at rare intervals the apprentice might take a notion to remove the accumulated drippings and this will mean a half a day of wasted time—not work.




SHELLAC HOLDER MADE OF A GLASS JAR, A WOODEN RING AND A TIN CAN

In the accompanying illustration is shown what I consider to be an easily made, plain, practical shellac container. It consists of a pint Mason fruit jar, a board having a hole the diameter of the jar cut in it and with the outside cut

as shown to act as a support for the cover and also as a handle by which to carry it. An empty fruit can with the top removed serves as a cover.

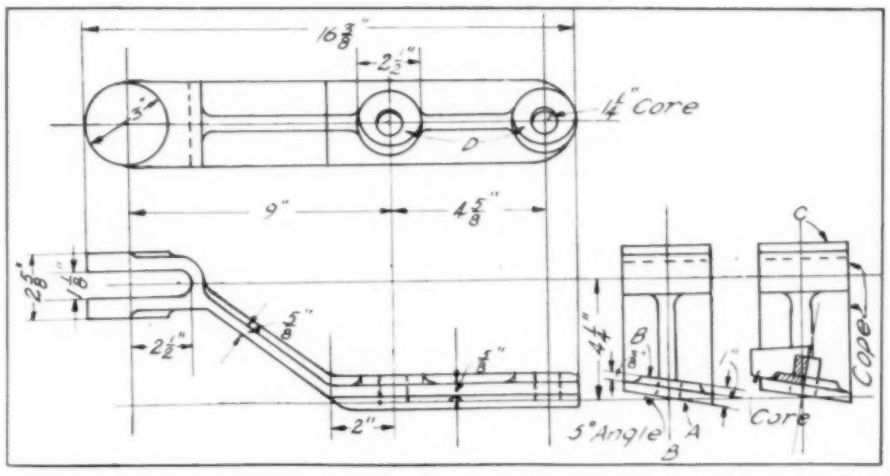
The board which is cut to a reasonably tight fit is slipped upon the jar to the desired height. A nail driven into the side of the brush and bent serves to hold it suspended above the varnish in the jar. The empty tin can forming the cover is lowered over the mouth of the jar until it rests on the board ring. It may be one or even two inches larger in diameter than the glass jar, be practically air tight and yet be free to be lifted off. When the outside of the jar eventually becomes gummed up it is not worth while cleaning it.

## Pattern Design Change Helps Production

*By Claude J. Morrette*

Demands made by casting buyers necessitate pattern equipment constructed according to the shop practice of the shop making the casting. Sometimes the attempt of the patternmaker to hold his cost to the absolute minimum has the effect of making the cheaply constructed pattern ultimately the most expensive.

The pattern shown in the accompanying illustration originally was split through the center line *AB*, with a loose piece at the point *A*; but apparently the patternmaker forgot to provide a second loose piece at the point marked *B*. This omission forced the molder to rap the pattern considerably to get it out of the sand and also resulted in an excess of metal in the casting.




THE ADDITION OF A CORE PRINT MADE IT POSSIBLE TO USE A SOLID INSTEAD OF A SPLIT PATTERN AND RESULTED IN MORE AND BETTER CASTINGS

The foundryman made a new pattern in one piece as shown at *C*. A core print carried square off the angle was placed on the inside of the 5-degree angle and extended up to the center of the pattern. The core which later filled the print formed the rib and the lower halves of the two bosses. The upper halves of the two bosses marked *D* were placed in their proper relative positions above the core print and two half core prints were added to take care of the 1¼-inch cored holes. The molder experienced no trouble in drawing this pattern out of the sand and the castings produced were not strained or over weight.

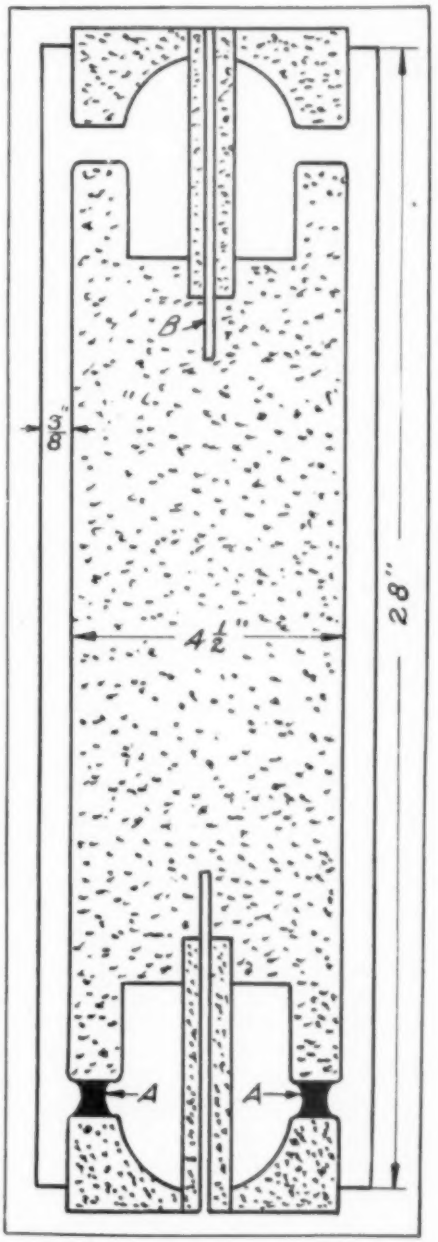
## Machine Work Reduced on a Bronze Plunger

*By Edward Navey*

Castings similar to the mine pump plunger shown in the accompanying illustration usually are cast in separate parts and afterward assembled. Recently several of these plungers were ordered in a hurry and with a view to saving a considerable part of the machine shop expense it was decided to make the casting all in one piece, that is to cast the crossheads integral with the body. The core offered the most serious obstacle to carrying out this plan. It was entirely surrounded by metal with the exception of a ½-inch hole through the center of each cross head. The vent from the core had to be taken off through these small holes at the ends and later the sand forming the core had to be removed through the same holes.

A ½-inch pipe pierced with numerous holes was used for an arbor in the first core. The core and also the bare pipe at each end were covered with a good coating of plumbago and with-

Facing sand for the mold was prepared from 75 per cent new sand and 25 per cent old sand. This sand was dried and then wet with clay wash until it assumed the consistency of molding sand. The core was made




THE VENT WAS TAKEN OFF THROUGH A ¼-INCH TUBE AT EACH END

of one-half each of river and silica sand bonded with linseed oil in the proportion of 40 to 1 and then wet down with a thin solution of a liquid binder. The casting was poured with phosphor bronze, a metal that is extremely *searching* and notwithstanding that it had to be poured hot on account of the thin walls, the plumbago covered core came out perfectly clean. The mold was cast on end in green sand. Three bronze chaplets or studs *AA* were employed to support the weight of the core. They also helped to solidify the metal in the cross head.

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## Depression Stirs Invention

DOUBTLESS the forthcoming equipment exhibitions to be held in Rochester, N. Y., and in Birmingham, England, during June will be notable for the innovations which will be offered in foundry machinery and supplies. Progress always has attended more faithfully upon eras of industrial and business stress as is evident from a chronological study of inventions; and the period now closing should prove to be no exception. A tendency toward refinement and reducing cost in existent types of equipment was noted early in 1921. This was followed shortly by the introduction of smaller and more economically operated units of existing machines, notably in sand handling machinery, cleaning room equipment and in sand tempering and preparing rigs. Small details of design which tended to cheapen production and aids to increased output followed. The time now is ripe for more marked advances. New and original methods in castings manufacture, centering on sand preparation and molding practice and extending through wide ramifications to the fields of permanent mold study are under consideration. Doubtless some of these investigations will bear fruit in the forthcoming gatherings of foundrymen and foundry equipment manufacturers in this country and abroad, and the exchange of ideas will be exceptionally profitable.

## Paying Low Price Penalties

DURING the lean months which, it is hoped, are drawing to a close, consumers have ordered castings with their attention fixed almost exclusively upon the price tag. Many foundrymen have suffered severely in their self-righteousness, when they have seen old customers, favored during the stress which marked 1918 and 1919, look about for the lowest bids during the past depression. They have felt, and justly in many cases, that users of castings who were favored when foundries were crowded to capacity and castings were scarce, should stand by them in hard times and not permit a few cents per pound to part old business friends. Retribution, like virtue in the play, has made its entrance. Many consumers are finding that familiarity with their peculiar problems and a certain technical ability acquired through practice are necessary in producing satisfactory castings. Some manufacturers who had placed orders for castings at cut rate prices, have seen their pile of rejects grow, and many have pulled the patterns from the sand and sent them back to those shops which in the past have demonstrated the satisfactory quality of their work. Factors other than mere price are coming again into repute. Nor is this feature confined to high class machinery castings alone. Consideration of ability to deliver on time schedule, a point in castings purchase which has been disregarded with impunity for the past few months, has been brought to the front on a large tonnage order in the East. Truly the buyers market obtains, but the buyer is coming to differentiate between the sellers he seeks, and to narrow the prospective list of foundries which can meet his specifications.

# Trade Outlook in the Foundry Industry

THAT the long pull back toward prosperity has started is evident in practically every phase of manufacturing activity. Foundry lines furnish no exception, though the quickening in contributing industries in many cases has not reacted to the point where castings orders are booked and the weekly melt increased. Nevertheless a better sentiment is present than has been noted for many months. This is reflected in purchases of iron, fuel, sand; and in replacement and repair parts for foundry equipment that has been idle.

**Contributing Factors**

At no time during the depression have the various basic conditions been more favorable for improvement in foundry operations. The main outlets for castings, practically without exception, are developing through the pickup in constructional lines, railway car and equipment purchases, automobile manufacture, advancing prices for farm products, activity in textile lines and extensions of municipal and public service facilities. According to figures compiled by the United States Department of Commerce, contracts for business and industrial buildings increased in January, both in floor space and value. Too, residential buildings contracted for in January totaled 18,083,000 square feet, valued at $75,728,000. Despite the usual seasonal decline, this was by far the largest amount of residential building ever undertaken in January. Residential construction has formed one of the most stable outlets for castings during the dull months just past and further improvement should give greatly added demand. Further, steps are suggested by various trade associations to establish part-payment plans for selling plumbing, heating and sanitary ware, with the object of increasing sales. This has been suggested by the success attending the marketing of automobiles by deferred payment plans.

**Automotives Active**

Although the closing months of 1921 used as a basis of comparison, offer a contrast which is perhaps unduly favorable, the spring sales of automobiles continue to furnish an active castings market. Reductions in prices of various standard makes has brought an increase in demand for tractors from rural districts and strong efforts are being exerted to popularize tractors for industrial use. Implement manufacturers are much more hopeful, following the rise in farm commodity prices. The buying power of some fifty million people is influenced by the price level of agricultural products, and despite the indebtedness piled up last fall, it is felt that the demand for implements will grow steadily. An improvement already is evident, notably in the southern and southwestern states, where the early season has brought active inquiry and a fair volume of sales.

**Prices of Raw Material for Foundry Use**

CORRECTED TO MARCH 9

| Iron | | Scrap | |
|---|---|---|---|
| No. 2 Foundry, Valley | $19.00 | Heavy melting steel, valley | $15.25 to 15.50 |
| No. 2 Southern, Birmingham | 15.00 to 15.50 | Heavy melting steel, Pitts. | 15.00 to 15.50 |
| No. 2 Foundry, Chicago | 20.00 | Heavy melting steel, Chicago | 11.75 to 12.25 |
| No. 2 Foundry, Philadelphia | 20.84 to 21.86 | Stove plate, Chicago | 14.50 to 15.00 |
| No. 2 Foundry, Buffalo | 18.25 to 18.50 | No. 1 cast, Chicago | 15.00 to 15.50 |
| Basic, Valley | 17.75 to 18.00 | No. 1 cast, Philadelphia | 17.00 to 17.50 |
| Basic, Buffalo | 18.50 | No. 1 cast, Birmingham | 16.00 to 17.00 |
| Malleable, Chicago | 20.50 | No. 1 cast, Buffalo | 16.25 to 16.50 |
| Malleable, Buffalo | 18.50 to 19.00 | Car wheels, iron, Pittsburgh | 15.50 to 16.00 |
| **Coke** | | Car wheels, iron, Chicago | 15.00 to 15.50 |
| Connellsville foundry, coke | $4.25 to 4.75 | Railroad malleable, Chicago | 13.25 to 13.75 |
| Wise county foundry, coke | 6.00 to 7.00 | Agricultural mal., Chicago | 13.25 to 13.75 |
| | | Railroad malleable, Buffalo | 13.00 to 14.00 |

**Car Buying Slackens**

Although the fall in weekly averages of idle freight cars continues, practically without interruption, buying of new railway cars and equipment has slackened during the first weeks of March. One interesting sidelight on the changing conditions is furnished by a recent inquiry from an eastern railway for repair castings. This inquiry covered its requirements for the next six months, and one large foundry refused to quote prices that far in advance, despite the attractive character of the order. Some stove foundries are working well above 50 per cent capacity. Castings prices vary widely, not only according to the character of the work offered, but also along lines which indicate an ignorance or disregard of costs. The Hudson river tunnel job, although not contracted, is typical. One offer on a portion of the total tonnage by a Pennsylvania foundry was stated to have been $46 per ton delivered, which with a freight deduction of almost $8 would have made the price in the neighborhood of $38. At the same time a contract recently was awarded by the city of Boston, involving 110,000 pounds of frames and covers for the water department. The price in this case was $95. Perhaps the best single indication of improved foundry conditions is contained in the increasing sales of iron. In eastern Pennsylvania, sellers of foundry iron reduced their quotations for several days to about $18 a ton and in that time received orders for over 40,000 tons. Although the total production of pig iron for February was slightly lower than in January, according to *The Iron Trade Review*, the daily average production showed a gain of 5130 tons in February. The total output of pig iron was 1,630,180 tons for last month, and 1,645,804 tons for the preceding period. The daily average production of iron for February was 58,220 tons and for the first month of the year was 53,090 tons.

**Nonferrous Brighter**

Early spring has seen a steady improvement in brass foundry operation, in line with building activity and automobile demand. Nonferrous prices, based on New York quotation in *The Daily Metal Trade* of March 9 follow: Casting copper, 12.75c; electrolytic copper, 13.00c; Straits tin, 29.12½c; antimony, 4.20c to 4.25c; lead, 4.70c to 4.75c; aluminum, No. 12 alloy, producers' price, 19.00c to 19.20c and open market, 14.00c to 15.00c. Zinc is 4.65c E. St. Louis. The average monthly prices for February follow:

(New York Quotations)

| Casting Copper | Electro. Copper | Lead | Tin Straits | Antimony | Zinc St. Louis |
|---|---|---|---|---|---|
| 12.67 | 13.26 | 4.70 | 30.72 | 4.38 | 4.50 |

# Comings and Goings of Foundrymen

WILLIAM B. PRICE, recently elected chairman of the Institute of Metals division of the American Institute of Mining and Metallurgical Engineers long has been a prominent figure in the field of practical and scientific metallurgy. After graduation from the Sheffield Scientific school he became connected with the Scovill Mfg. Co., Waterbury, Conn. and since that time, for 20 years he has been the chief chemist and metallurgist for that company. Among his extensive contributions to technical literature, perhaps the best known is his "Technical Analysis of Brass and Nonferrous Alloys."

F. J. Carrigan, who for many years has been foundry foreman for the Nevada Consolidated Copper Co., McGill, Nev. has purchased the Cottage Grove Iron & Brass Foundry from James Feeny, its former proprietor.

Edgar L. Pond, president of the Andrew Terry Co., Terryville, Conn., operating the oldest malleable iron foundry in that state, observed the 50th anniversary of his connection with the company, March 4. He became a director and secretary of the company in 1896, treasurer soon afterwaards, and president in 1898.

Charles Hayden has been elected chairman of the board of the International Nickel Co., succeeding the late E. C. Converse. Robert E. Stanley has been elected president to succeed the late Mr. Bostwick. Mr. Stanley was vice president and general manager of the company. Britton Osler and J. L. Agnew were elected directors.

Henry Harnischfeger, president of the Pawling & Harnischfeger Co., Milwaukee, manufacturer of material handling machinery, has sailed for the Orient and Europe. He will visit the various foreign branches of the Associated Machinery Corp., an export organization of which the Milwaukee company is a member and of which Mr. Harnischfeger also is president.

Arthur Whitcraft has assumed charge of the manganese steel sales department of the Hadfield-Penfield Steel Co., with headquarters at Bucyrus, O. Mr. Whitcraft was for a number of years successively with the Marion Steam Shovel Co., American Locomotive Co. and the New York Central railroad, in charge of erection and operation of heavy excavation machinery. For 12 years he was a sales engineer with the American Manganese Steel Co. During the war period he served as captain in the ordnance department. Retaining his interest in military affairs, he is at present a captain in officers reserve corps of the army.

Samuel R. Robinson, formerly foundry superintendent, Sandusky Foundry & Machine Co., Sandusky, O., has accepted a position as metallurgist for the Lorain Steel Foundry Co., Lorain, O. Mr. Robinson was metallurgist for the Philadelphia Roll & Machine Co. from 1918 to 1921. Previously he was metallurgist for 11 years at the Duquesne Steel Foundry Co., Coraopolis Pa.

E. W. Smith, foundryman with the Crane Co., read a paper on molding sand before the Chicago Foundrymen's club at the regular monthly meeting held at the City club, March 11. Discussion of the paper was led by R. E. Kennedy and R. A. Bull, secretary and chairman, respectively, of the joint committee on molding sand research of the National Research council and the American Foundrymen's association.

## Describes Some European Foundry Practices

"Recent Developments in European Foundry Practice" is the subject of a paper prepared by Dr. Richard Moldenke of Watchung, N. J., for the regular March meeting of the New England Foundrymen's association to be held in Boston at the Exchange club. Dr. Moldenke has many interesting sidelights of the situation, and a good idea of European methods.

## Metallurgical Engineers Elect Officers

Officers of the institute of metals division, of the American Institute of Mining & Metallurgical Engineers elected at the annual meeting held in New York the week of Feb. 20 are: Chairman, W. B. Price, Scovill Mfg. Co., Waterbury, Conn; vice-chairman, George K. Elliott, Lunkenheimer Co., Cincinnati; secretary-treasurer, W. M. Corse, Monel Metal Products Corp., Bayonne, N. J. The following executive committtee was elected for the ensuing year: George K. Elliott; C. T. Bragg, Michigan Smelting & Refining Co., Detroit; H. M. Lane, H. M. Lane Engineering Co., Detroit; Lawrence Addicks, New York; William Campbell, Columbia university, New York; J. A. Capp, General Electric Co., Schenectady, N. Y.; E. E. Thum, McGraw-Hill Co., New York; George F. Comstock, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.; W. A. Cowan, National Lead Co., Brooklyn; and H. M. Williams, General Motors Research Corp., Dayton, O.

## Philadelphia Foundrymen Shown Steel Works

A 4-reel moving picture of the plant of the Bethlehem Steel Co., Bethlehem Pa., was shown at the meeting of the Philadelphia Foundrymen's association held at the Manufacturers club, that city, Wednesday evening, March 8. The copy of a standardized pig iron contract was submitted by a representative of the National Association of Purchasing Agents for endorsement by the association.

## Pennsylvania Adopts New Safety Code

Definite steps to remove the eye hazard, increasing at an alarming rate in industry, will be taken during the coming year, according to plans of Commissioner Clifford B. Connelley, department of labor and industry for the state of Pennsylvania. After more than two years' study the industrial board has completed revision of safety standards governing head and eye protection. The code was completed and adopted last July and now is available for distribution in printed form. Protectors are required in seven separate occupations enumerated in the new code as follows:

Oxyacetylene and other compressed gas welding and burning.

Chipping.

Electric welding.

Grinding wheel dressing and rough emery.

Iron tapping at cupola.

Sand and shot blasting.

Thermit welding.

Goggles, masks, hoods and shields are recommended as protectors for certain lines of work. In every one of the mandatory occupations, goggles are required with the exception of sand and shot blasting where a hood is required.

A worker who loses a hand or foot may be trained in some gainful occupation, but a man who loses one or both eyes stands little chance of getting back as a producer. The employer will realize what it means when one of his employes loses an eye through having failed to take the necessary precautions when he learns that $1,005,414 was awarded last year for 677 eye losses, while $1,275,487 in compensation was awarded for 648 leg, arm, hand and foot losses combined. Compensation also is required now for facial disfigurement. This hazard would be minimized by compliance with the new code. The first case coming under this provision of the compensation law was disposed of in an award of $600 for the loss of an ear.

The code sets forth both employers' and employes' responsibilities. Employes are required to use all safeguards, safety appliances or devices furnished for their protection. Each employe is responsible for carrying out safety standards which may concern or affect his conduct. The safety standards committee has on hand a number of goggles, masks and hoods which will be approved after tests have been made now that the code is in force. Owing to urgent need for immediate action the laboratories of the Pennsylvania State college and the United States bureau of standards will be used to make the tests. Certain classes of goggles must be able to withstand heat and percussion against flying particles as well as radiant energy.

## Obituary

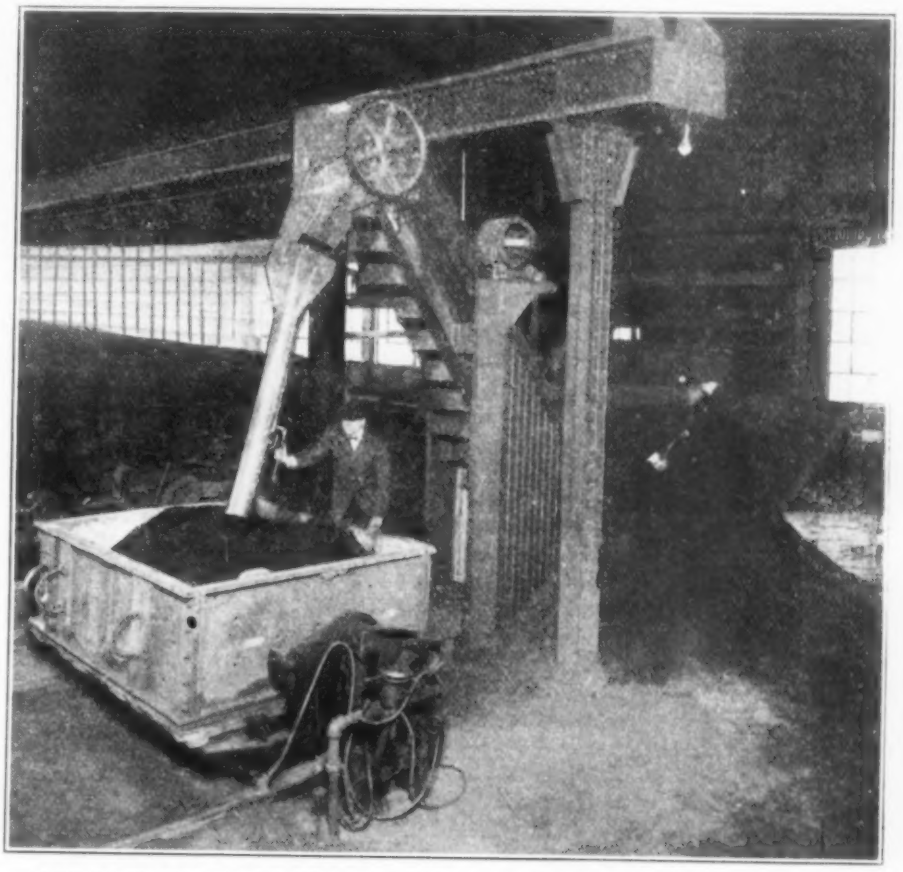
Charles Stuart, vice president of the Fagan Iron Works, Jersey City, died March 1, at his home in Weehawken, N. J. Mr. Stuart was born in England and had been with the Fagan company for 30 years.

Otis Henderson Cutler, chairman of the board of the American Brakeshoe & Foundry Co. died suddenly March 4, aboard the yacht SERAMIO, at Miami, Fla. Mr. Cutler was educated at the Rockland Military Academy, Nyack, N. Y., and Washington Law university. He served as a clerk in the United States senate from 1884 to 1895 and for the following three years was a member of the New York state assembly from Rockland county. Mr. Cutler began his business career with the North River Bridge Co., which he served as secretary from 1895 to 1900 and for the next two years he was manager of the Ramapo Iron Works. He became vice president and general manager of the American Brakeshoe & Foundry Co. in 1902 and in 1903 was made president serving until 1916, when he retired as president and was made chairman of the board of directors. During the world war, Mr. Cutler served as manager of the insular and foreign division of the American Red Cross.

Col. John Sargeant, president of the Domhoff & Joyce Co., who died March 4 at a Buffalo hospital where he had gone for special treatment, was widely known and highly regarded in the pig iron and coke trades. Colonel Sargeant was born May 10, 1862, in the village of Wass, northern Yorkshire, Eng. He came to this country at the age of 17, securing a position in the claims department of Southern railroad at Cincinnati. In 1889 he left the railroad service, associating himself with the Matthew Addy Co., Pittsburgh iron merchants. In 1896 he organized the Domhoff & Joyce., then a small sales concern engaged in the pig iron and steel trade. Now it maintains sales offices in New York, Chicago, Cleveland, Indianapolis and St. Louis with main offices in Cincinnati. Colonel Sargeant was president and treasurer of this concern, was president of the South Dayton Railway Co., director of the Campbell County bank, Bellevue, Ky., and was interested financially in numerous business enterprises.

## Machine Delivers Sand into the Flask

A machine for delivering molding sand into the flask has been developed by the Osborn Mfg. Co., Cleveland. The accompanying illustration shows one of these machines of the self-contained, stationary type filling a flask on a jar, rollover machine. It is also planned to build a portable flask filler which can be moved from one molding machine to another as needed.



OPERATION OF THE FLASK FILLING MACHINE IS CONTROLLED BY TWO BUTTONS ON THE DELIVERY TUBE

The machine is made up of structural shapes with suitable mechanism at each end for supporting sprocket wheels, upon which are mounted standard link chains. Specially shaped buckets are attached to the chains. In the stationary machine the entire outfit stands alone without support. A flexible discharge chute is attached at the upper end of the machine so located that sand may be discharged into all the corners of the flask.

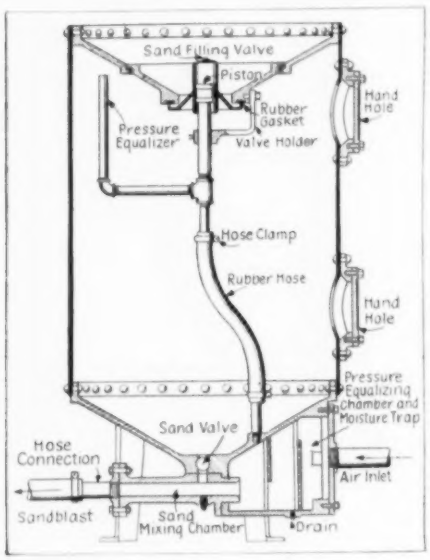
The machine is driven by an electric motor, the capacity of which is governed by the amount of sand to be handled. Two cubic yards of sand per minute require a 15-horsepower motor. The motor is controlled by push buttons located on the end of the discharge chute. Thus the starting and stopping operations are under the control of the operator. This allows

the machine when not actually elevating sand to be entirely shut off, thus eliminating a great deal of wear and tear.

The machine may be placed either with the receiving buckets at the floor level or below the floor. It is recommended that, where possible, the machine be located with the bucket extending several feet below the floor, with an open grating at the floor level. It is intended that, as the sand is being cut by a sand-cutting machine, it gradually be worked into a heap around the sand loader, where a clamshell bucket could be used to advantage in charging it.

## Single Valve Controls Sand Blast Tank

Simplicity and efficiency of operation as exemplified by a single control valve are claimed as outstanding features by the industrial Air Engineering Co., Elyria, O., for the sand blast tank




ALL THE USUAL FUNCTIONS OF THE TANK ARE CONTROLLED THROUGH ONE VALVE WHICH MAY BE PLACED AT ANY POINT CONVENIENT FOR THE OPERATOR

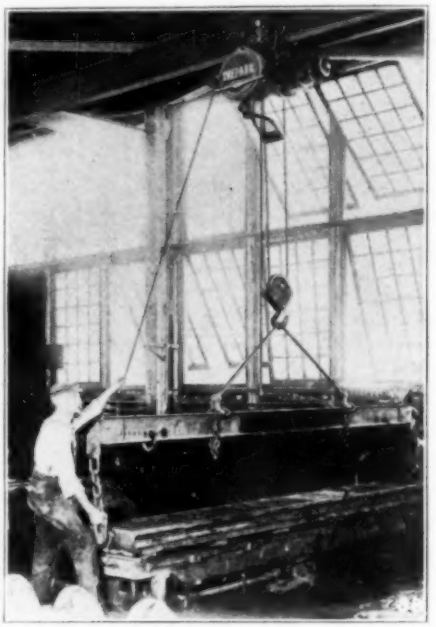
shown in the accompanying illustration. The compressed air enters the pressure equalizing chamber and moisture trap shown at the extreme lower right hand corner of Fig. 1. Oil and water vapor condensing in the pipe line leading to the tank from the compressor are separated from the air current and collected on herringbone surfaced baffle plates. The moisture drains toward the side walls and accumulates in the bottom where it may be drained off through a small opening provided for that purpose. When the plug is removed from the drain hole, the air pressure drives the accumulated drippings through the hole. The chamber also serves as a cushion to neutralize the pulsation of the compressor.

To insure a constant and uniform flow of sand through the mixing chamber, it is essential that the pressure above the sand in the tank and below the tank in the mixing chamber should be maintained at a common level. The equalizing chamber serves this purpose by maintaining a pressure above the sand through a pipe on the inside of the tank and below the sand in the mixing chamber, through a pipe leading directly into the equalizing chamber. The various areas of the pipes and chambers are proportioned so that the compressed air when entering the equalizing chamber first passes through the air line on the inside of the machine and into the sand filling valve. The air line terminates in a stationary, hollow piston operating in a cylinder which serves as a sand filling valve. When the air is turned on, the sand valve is pressed tightly against a rubber gasket and thus seals the tank. The space above the sand in the tank then is filled with air under pressure through the branch pipe which extends above the sand level. With an equal air pressure above and below, the sand will flow by gravity into the sand mixing chamber through the valve provided in the bottom head for that purpose. When the air is shut off, the sand-filling valve will fall by gravity and admit a fresh supply of sand. The further flow of the remaining sand in the tank is checked by the baffle plate in the mixing chamber. By the time the operator has rearranged his work the machine will be refilled and ready for operation.

## Small Electric Hoist Hand Controlled

To provide an electric hoist for small and medium loads is the purpose of a small general utility hoist recently announced by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. It is claimed that it can be applied to advantage in lifting anything within its capacity and carrying it practically any place. Heretofore, the impression has prevailed to a certain extent that an electric hoist could be used only for big, heavy rehandling jobs. The hoist shown in the accompanying illustration is particularly designed for and suited to all the usual lifting jobs encountered in factories, mills and warehouses. Wherever hand labor now is employed for lifting or carrying it is stated that this hoist affords more economical means of doing the work.

It can be operated wherever electric current is available and easily may be installed on the side of a building, on the ceiling or in any location that will bear the weight of a load. The track may be extended to various points



SMALL HOIST DESIGNED FOR AUXILIARY SERVICE

making possible the moving of a load quickly from place to place or direct to shipping platform. The overhead track takes up no valuable floor space. An overhead structure economically may be erected for out door or yard use.

## Study Aluminum Alloys

Commercial melting practice for aluminum and its light alloys has been studied in a preliminary way by the United States bureau of mines. The purpose of this investigation is to ascertain the metal and fuel losses in melting aluminum and its light alloys in the United States, and to determine the preferable methods of melting. A preliminary report, to be issued as a bulletin, has been prepared. This gives a comparison of the performance of different types of furnaces, metal and fuel losses, and furnace efficiencies.

## Patent Requests Grow

Applications for patents during 1921 totaled 84,248, states Thomas E. Robertson, patent commissioner, in his annual report, compared with 81,948 in 1920 and 62,755 in 1919. Total patents granted and trademarks, labels and prints registered in the year ended June 30 were 53,817, against 47,409 in 1920 and 43,353 in 1919. Emphasis again is laid upon the need for relief of the patent office, as many of the divisions are now 11 months behind.

# Drift Changes in Equipment Market

## Replacements Indicate Quickening Interest and Growth in Volume and Quality of Inquiry for Foundry Machinery, Furnish Encouraging Evidence of Buying Tendencies

IMPORTANT indications are observed which point to improvement in foundry equipment sales. Repair orders are growing and inquiries for molding, sand-blast, sand handling and melting installations give evidence of this tendency. A Michigan malleable foundry making automobile castings endeavored less than sixty days ago to sell some molding machines which were regarded as surplus equipment. Recently this same company withdrew its offer and is buying replacements and repairs for its entire battery of machines. The Harris Foundry Co., Vancouver Ave. at Tillamook St., Portland, Oreg., is inquiring for light molding machines for plumbing castings. The Westinghouse Electric & Mfg. Co., Cleveland, is inquiring for tumblers and sand blast machinery, and the Cuyahoga Foundry Co. of the same city is interested in a small cupola to supplement its larger furnace. Eugene Forrer, Budd Lake, N. J. contemplates constructing a small foundry near New York to make plumbers' fittings, valves, light machinery and pumps. S. J. Stewart, Superior Brass & Copper Foundry, 531 St. Joseph St., New Orleans, La. states that his company wishes to purchase a light molding machine and a squeezer.

### *Improvement Anticipated in Pittsburgh District*

THAT the foundry equipment industry in the Pittsburgh district is scheduled for improvement within the next month or so is the consensus of opinion among sellers and manufacturers. Some representative houses report the sale of minor equipment daily, and inquiries are exceedingly plentiful. Foundries are improving their operating schedules and are buying more coke, pig iron, facings, etc., all of which makes the immediate future bright from an equipment selling standpoint. Sales consummated recently include a sand mixer by the Blystone Mfg. Co., Cambridge Springs, Pa., to a nearby user and an 8-foot sand mixer made by the National Engineering Co., Chicago, to the National Radiator Co., New Castle, Pa. The latter company recently purchased a large rollover molding machine now being installed by the Herman Pneumatic Machine Co., Pittsburgh. Inquiries for molding machines are numerous but orders largely continue to be withheld, one from Patton Bros., Marietta, O., for a large rollover machine being the last one received by the Herman Pneumatic Machine Co. since those last reported. Buyers of flasks, copes, drags, riddles and other small supplies are manifesting more life, the Carnegie Steel Co. buying a sizable lot of flasks recently. The Ruud Mfg. Co. purchased a large japanning oven and a local foundry bought a motor driven emery grinder. The Stevenson Co., Wellsville, O., has closed on its cupola and blower, and purchases of cupolas, flasks and a large amount of other equipment for a nearby foundry which now is being constructed are about to be made. The Enterprise Foundry Co., Pittsburgh, recently suffered much damage from a fire and doubtless will replace considerable equipment. The Sharpsburg Foundry Co. closed on a 5-ton Shaw crane, but has not started as yet on the remainder of its foundry equipment. An oil well supply manufacturer near Oil City, Pa., bought a 15-ton locomotive crane from the Brown Hoisting Machinery Co., Cleveland. The Precision Brass & Bronze Foundry, 1001 Chestnut street, Philadelphia, has issued a list of the machinery it wants for its machine shop as well as foundry.

### *Replacements Strengthen Eastern Market*

INQUIRY for foundry equipment is coming out on a steadily increasing scale and is for the most part confined to miscellaneous items for replacement purposes. Few new projects are reported, which accounts for the scarcity of sizable lists. The improvement now being noted is attributable to a betterment in operations at many of the jobbing plants. While production at these shops varies widely, it appears safe to assert that on an average, operations are around 40 per cent. Another element in the increase in demand is the keenness of competition, which in many cases makes installation of new and more efficient equipment advisable. While no details have been announced, it is said the American Machine & Foundry Co. will make alterations to its plant in Brooklyn, for the manufacture of elevators. The Brooklyn company recently acquired a substantial interest in the Gurney Elevator Co., Honesdale, Pa., whose elevator it will manufacture. The Gurney plant at Honesdale, Pa. will continue operating. The Segal Lock & Hardware Co., Springdale, Conn., has begun the erection of a foundry, and the Electrical Foundry & Equipment Co., Philadelphia, has also started work on a new addition. The Prudential Iron Works, 633 Concord avenue, New York city, has purchased property for a plant addition. The East Penn Foundry Co., Macungie, Pa., is going ahead with various alterations.

### *Improved Tone to Chicago Inquiry*

IN GENERAL, sellers of foundry equipment find buyers in a more receptive mood than during past months, and inquiry in their line is more active. Engineers and architects having to do with foundry construction find little tendency to build new plants or make extensive changes in existing foundries. Somewhat better volume of buying is noted in ladles and supplies, as increased melt by foundries requires more of these materials. In molding machines, inquiry is larger than formerly, but selling is slow and for the most part confined to single machines and lots of two or three. A number of sales of rockover and jolt machines for various sections of the country are reported. Inquiry for cupolas is moderate and several have been sold recently. The Whiting Corp. has orders for cupolas from the Filer & Stowell Co., Milwaukee, and the Damez Foundry Co., Chicago, as well as two others for eastern users. The same company has disposed of several cranes recently, including two 15-ton cranes for the Kewanee Boiler Co., Kewanee, Ill., a 55-ton crane for the City of Lansing, Mich., a 1½-cubic yard bucket crane to the Lewes Fertilizer Co., Philadelphia and a 3-yard bucket crane to the Central Illinois Power Co., Harrisburg, Ill.

# What the Foundries Are Doing

## Activities of the Iron, Steel and Brass Shops

Alterations are being made at the plant of the East Penn Foundry Co., Macungie, Pa.

The James Graham Mfg. Co., Newark, Cal., manufacturer of stoves, etc., is reported planning the erection of a plant building.

The San Pablo Pattern Works, Oakland, Cal., recently was organized by J. C. McCausland, R. McIntosh and J. Griswohl.

The Elgin Stove & Oven Co., 14 Chicago street, Elgin, Ill., is reported planning the erection of a 2-story factory building.

The Arcade Mfg. Co., Freeport, Ill., has had plans prepared for the erection of a plant building, three stories, 66 x 98 feet.

The Segal Lock & Hardware Co., Springdale, Conn., has started work on the erection of a foundry building.

The Electrical Foundry & Equipment Co., Philadelphia, recently started work on the erection of an addition to its plant.

The Shreveport Foundry & Machine Co., Cedar Grove, La., is reported planning to remove its plant to Bossier City, La.

A 1-story addition to its plant is under construction by the Crompton & Knowles Loom Works, Providence, R. I.

The Sunnyside Bronze Foundry, New York, recently was incorporated by O. S. Berger, K. Rippel and J. Forman. The company is represented by A. Lipton, 160 Broadway.

Property has been purchased by the Prudential Iron Works, 633 Concord avenue, New York, as a site on which it plans to erect an addition to its plant.

Capitalized at $100,000 the Weber & Hunt Machine & Tool Works, Newark, N. J., recently was incorporated by John Weber, George Hunt and Anthony Remondelli.

Erection of a pattern shop is reported under consideration by the American Cast Iron Pipe Co., Sixteenth and Thirtieth avenue, Birmingham, Ala.

The Moore White Co., Philadelphia, has started work on the erection of an addition to its foundry building, two stories, 60 x 164 feet.

C. F. Cox, Lemuel Stansell and others are named as incorporators of the Southern Foundry & Machine Co., Belton, S. C., which was recently incorporated with a capital stock of $10,000.

A gray iron foundry and several additions to the machine shops and erecting floor will be built by the U. S. Tractor & Machinery Co., Menasha, Wis., according to a report from that city.

Capitalized at $50,000, the Pacific Malleable Iron Co., Gresham, Oreg., recently was incorporated by M. Moga and others. The company is reported planning the erection of a foundry building at an estimated cost of $10,000.

Capitalized at $12,000, the Louis Meskan Brass Foundry, Inc., 422 South Robey street, Chicago, recently was incorporated by Louis Meskan, Edward Schauble and others, to conduct a brass and iron foundry.

The Canadian Aluminum & Brass Co., Ltd., Walkerville, Ont., recently was incorporated with a capital stock of $250,000, by John P. Carritte, Hiram H. Walker and E. M. McLean.

H. V. Beborfald, B. F. Vineburg and P. E. Uhr were named as the incorporators of the Union Port Brass Foundry Co., New York, which was recently chartered with a capital stock of $50,000.

The Niagara Radiator & Boiler Co., Tonawanda, N. Y., is building a foundry and machine shop at 1101 East Eighty-third street, Chicago. The company also plans to build in the near future a 4-story warehouse.

The Rawson Moulding Co., Waltham, Mass., recently was incorporated to make dies and molded appliances, with a capital stock of $50,000, by Homer E. Rawson and Harold R. Michaelson, both of Boston, and Alfred H. Grebe, Richmond Hill, N. Y.

Incorporated to manufacture and deal in stoves, furnaces, etc., the National Stove & Furnace Co., 510 South Front street, Quincy, Ill., recently was chartered under the laws of Illinois, by C. H. Wood, John J. Fisher and W. J. Fisher.

The Wichita Falls Foundry & Machine Co., Wichita Falls, Tex., will build a new plant at Railroad and New York avenues, Ft. Worth, Tex., and remove its present works to that location. Property for the new plant has been purchased.

The Crown Foundry Co., Peoria, Ill., was recently organized to do a general foundry business in gray iron. It now is erecting a plant, 50 x 124 feet, which it is expected will be ready about the middle of April. Incorporators of the company are Frank Barr, O. B. Slater, H. E. Hire and J. D. Armstrong.

Expected to be ready for operation by March 20, the new plant of the Lynn Iron Foundry, Inc., West Lynn, Mass., now is being occupied. The company, which is capitalized at $20,000, plans to manufacture light gray iron and heavy gray iron castings and special lines of cylinders, exhaust pipes, etc., in addition to conducting a jobbing business. Officers of the company are: President, T. Mailloux; vice president, E. Rocheleau; treasurer and general manager, J. T. Pellitier and office manager, M. Morin.

Purchase was made recently by the Mead-Morrison Mfg. Co., East Boston, Mass., of the plant of M. Beatty & Son, Welland, Ont., manufacturers of marine equipment. It will be operated as the Canadian Mead Morrison Co., Ltd., and will be in charge of D. W. Coe, with headquarters in Montreal. Mr. Coe was formerly connected with the East Boston plant. The company will continue the production of marine equipment and in addition it will build a line of hoists. While expansion of facilites at the Welland plant is contemplated no definite plans have as yet been made.

## New Trade Publications

VISES—The Atlas Vise Co., Inc., Lowville, N. Y., has published a 4-page folder in which a combination machinists' and pipe fitters' vise with swivel base, anvil and shear, and a portable combination vise, and special attachments, are described and illustrated. Specifications are given.

POWDERED COAL—The Bonnot Co., Canton, O., has published a 16-page illustrated booklet in which the use of pulverized coal for melting iron in the air furnace is described. The data given in the booklet are based upon reports of exhaustive tests made by the Chicago Railway Equipment Co.

BAFFLES—The Quigley Furnace Specialties Co., Inc., New York, is circulating a 4-page leaflet in which the use of a refractory material, which it manufactures, in making one-piece baffles of refractory concrete is described. The bulletin is well illustrated and tells an interesting story of the experience of a Brooklyn company.

MALLEABLE IRON—The American Malleable Castings association, Cleveland, is circulating a 16-page booklet containing reprints of advertisements which have appeared in leading publications in the automotive, railway, farm implement and general industrial fields, pointing out how malleable castings, measuring up to the standards adopted by the association, are meeting engineering and production requirements.

BUILDING CONSTRUCTION—Dwight P. Robinson & Co., New York, is circulating an illustrated folder containing illustrations of factory and office buildings which it recently erected. These include the plants of the Mutual Enamelware Co., Chattanooga, Tenn.; Proctor & Gamble Co., Dallas, Tex.; Armour Fertilizer Works, Chicago Heights, Ill.; American Rolling Mill Co., Middletown, O.; Westinghouse Electric & Mfg. Co., Essington, Pa., and a number of others.

AIR TOOLS—The Turbine Air Tool Co., Cleveland, has published a 12-page illustrated booklet in which tools are described and illustrated. Drills, grinders and planers are described in the booklet. An important feature of these tools is that the turbine is not a wearing part. It is suspended on ball bearings and between its outside rim and the inside of the housing there is a clearance of 1/32-inch. It is literally suspended in the air and revolves without friction.

PULVERIZED FUEL—Hardinge Co., New York, is circulating a 48-page illustrated booklet in which pulverized fuel systems are described and illustrated. The booklet goes into detail concerning preparation of this fuel, its transportation and burning. Applications which have proved successful include the following: Annealing furnaces, bar heating furnaces, bloom and billet furnaces, boilers, busheling and puddling furnaces, calcining furnaces, cement kilns, continuous heating furnaces, forging, galvanizing pots, ingot furnaces, malleable iron melting furnaces, and others. The booklet gives a detailed description of the various parts, etc., of the system.

TUMBLING BARREL—The Industrial Air Engineering Co., Elyria, O., has published an 8-page illustrated bulletin in which a sandblast tumbling barrel is described and illustrated. According to the booklet, operation is simple. The loading door provided in one of the barrel heads is brought to the top and opened. The material to be sandblasted is thrown in until the barrel is about half filled. The door is then closed and locked and the barrel is set in rotation by tight and loose pulleys, which drive the sprockets and which in their turn drive the friction rollers on which the barrel rests. The pieces to be sandblasted inside of the barrel are turned over vertically by the rotation and horizontally by the eccentric construction of the barrel. This eccentric construction forces a continuous turning and rolling over of every piece and in this way each is exposed to the sandblast stream which enters the tumbling barrel opposite the loading door.